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AEMT Wind Tunnel Test Data
from University of Washington Venturi Tunnel

by R. M. Hubbard

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ABSTRACT

A series of wind tunnel tests was conducted from 15 April 1979 to 14 June 1979 at the University of Washington's 3-ft Venturi tunnel to gather data relevant to the solution of a propulsion problem and to support a fin redesign effort for the Advanced Expendable Mobile Target (AEMT). This report outlines the test setups, describes the types of tests performed, and presents selected results. In addition, all of the raw data gathered during the tests are contained in an appendix.

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1. INTRODUCTION

A series of tests was performed on the Advanced Expendable Mobile Target (AEMT) vehicle at the University of Washington's (UW) 3-ft Venturi Wind Tunnel from 15 April 1979 to 14 June 1979. The test program was designed to complement a previous test series[1] performed in the 8-ft wind tunnel at the Guggenheim Aeronautical Laboratory of the California Institute of Technology (GALCIT). The previous tests had been limited to the evaluation of hull and fin hydrodynamics. They resulted in an essentially clean bill of health for the hull, but revealed a problem with flow separation on the fins.

In order of priority, the objectives of the UW tests were:

(1) Collection of data needed to correct design problems with the vehicle propulsion and fin hydrodynamics.

(2) Collection of data for predicting the vehicle's performance in future field trials.

(3) Confirmation of previously postulated causes of design problems.

(4) Contribution to the data base for hydrodynamic characterization of the AEMT vehicle.

The tests were formulated to achieve specific goals that had been established from the objectives. These goals were:

(1) Measure thrust and torque characteristics of various candidate propellers when operating in the wake of the hull.

(2) Measure wake velocity and take static pressure profiles of the self-propelled vehicle.

(3) Assess propeller inflow effects, including the effect on the propulsive coefficient of fully turbulent flow on the hull.

(4) Apply flow visualization techniques to detect flow separation on the propeller blades.

(5) Verify that the chosen fin section gave attached flow over 85% of chord.

(6) Measure improvements in fin drag, lift, and flap effectiveness.

(7) Measure static stability of the vehicle both for normal hull flow and for flow tripped at nose.

(8) Tailor fin size so as to achieve neutral static stability.

(9) Measure drag of the fully appended hull for natural transition and for tripped flow.

With the exception of goal 4, which was found to be impractical, all of the preceding goals were achieved to a degree sufficient to satisfy the objectives of the test program. It should be noted that, although the wind-tunnel data formed a necessary ingredient, confirming previously postulated causes of design problems required considerable additional theoretical analysis, which is reported in Reference 2.

2. PURPOSE AND SCOPE

The primary purpose of this report is to preserve the raw data that were acquired during the AEMT vehicle tests at the UW facility but that were not utilized in the diagnosis of the vehicle's propulsion problem. The reduction and analysis were limited to data that had a direct bearing on the problem. Therefore, the residual data represent an untapped source which should become part of the data bank on hydrodynamics technology generated by the AEMT program.

3. FACILITY DESCRIPTION

3.1 Basic Facility

The University of Washington's Venturi Wind Tunnel, a facility designed for student use, is located in Guggenheim Hall adjacent to the F.K. Kirsten Wind Tunnel. The design is a semi-open circuit with the return air path through the room enclosing the tunnel. The tunnel has a 36 in. (minor axis) hexagonal test section 36 in. long, an overall length of 22 ft, and is housed in a room 14 x 27 x 12-1/2 ft. A two-bladed, aircraft-type propeller located at the downstream end of the diffuser section exhausts directly into the room. The propeller is driven by a 10 hp dc motor with manual speed control. A large (3 in. mesh) honeycomb is installed across the open end of the inlet cone to straighten the flow. The test section is provided with a three-component, manually read, automatic beam balance having a resolution of 0.5 g. The force balance utilizes mechanical contacts and thyratron motor controllers to achieve self-balancing. The tunnel achieves a maximum dynamic pressure of approximately 18 psf (pounds per square foot) at an air temperature of 75°F.

3.2 Modifications

Initial tests were designed to assess the suitability of the facility for laminar flow testing. The tunnel exhibited severe surging at dynamic pressures (q) between approximately 15 psf and the maximum of 18 psf. A survey using tufts of nylon yarn taped to the diffuser walls revealed serious flow separation and unsteady recirculating flow. An attempt to improve flow attachment by installing a double row of vortex generators near the inlet to the diffuser section (Fig. 1) was only partially effective; however, AEMT program scheduling precluded further improvement, and testing proceeded at a reduced dynamic pressure of 16 psf.

Figure 1.   Double row of vortex generators installed near inlet to diffuser section.

Initial plans for the wind tunnel tests[3] anticipated that the flow-straightening honeycomb might generate an excessively high turbulence level in the tunnel, thereby precluding testing with laminar flow on the hull. Initial hull flow visualization tests confirmed this. An effort was made to reduce the turbulence level in the tunnel by removing the inlet honeycomb. However, this created an unsteady cross flow in the

test section which caused severe vibration of the model. Further flow visualization tests revealed that the large-scale turbulence generated by the honeycomb did not preclude achieving laminar flow on the fins. Therefore, the decision was made to proceed with fin testing and propeller selection, and to postpone tests dependent on laminar flow on the hull.

The problem of installing turbulence-control screens was addressed on completion of the abbreviated test series. Fortunately, a successful solution was found in the form of three layers of aircraft structural honeycomb (0.20 in. mesh) wired to the downstream face of the flow straightening honeycomb on the inlet (Figs. 2 and 3). The addition of the turbulence-control screens reduced the maximum achievable q from 18 psf to 10 psf. At 10 psf, the tunnel was still subject to surging, thereby limiting the low turbulence testing to a nominal q of 9 psf. All the laminar flow tests were conducted at this latter q.

4. EXPERIMENTAL SETUP

4.1 Hull Model

A full-scale model of the AEMT hull, in both unpowered and powered configurations, was mounted to the two support forks by an offset trunnion as shown in Figures 4 and 5. The mounting was designed to preclude impingement of trunnion flow on the tail fins while eliminating the requirement for one-moment transfer. The longitudinal support point was as far aft as practical to preclude premature tripping of the flow while still not exceeding the maximum pitching moment capability of the beam balance. The pitch arm was pinned to a tab at the tip of the lower vertical fin.

The forebody of the hull was actual field test hardware; the afterbody was a spare, identical to the field test unit.

4.2 Fin Model

An ellipsoidal support body was used for the fin testing (Fig. 6). The body was slotted to accept individual semispans which were restrained by set screws. An adjustable crank arm was installed in each side of the support body to permit fixed deflection of the flaps. The amount of deflection was measured with a machinist's scale based on movement of the trailing edge from a scribed neutral position.

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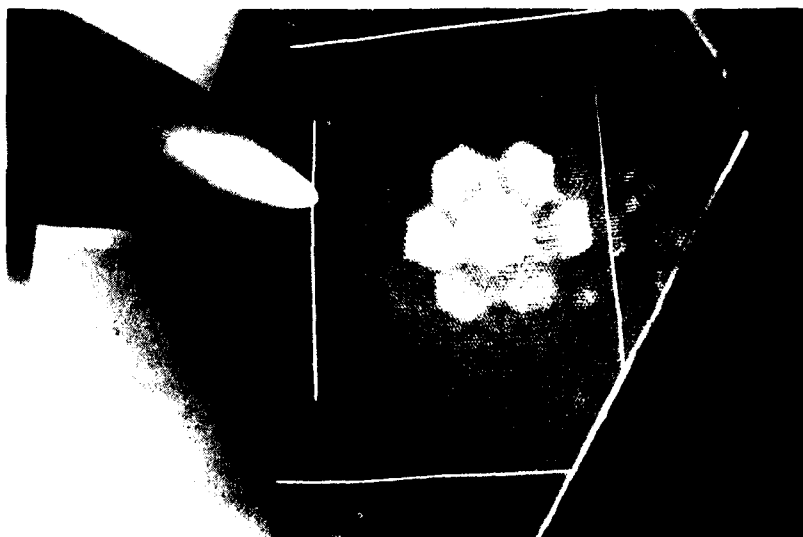
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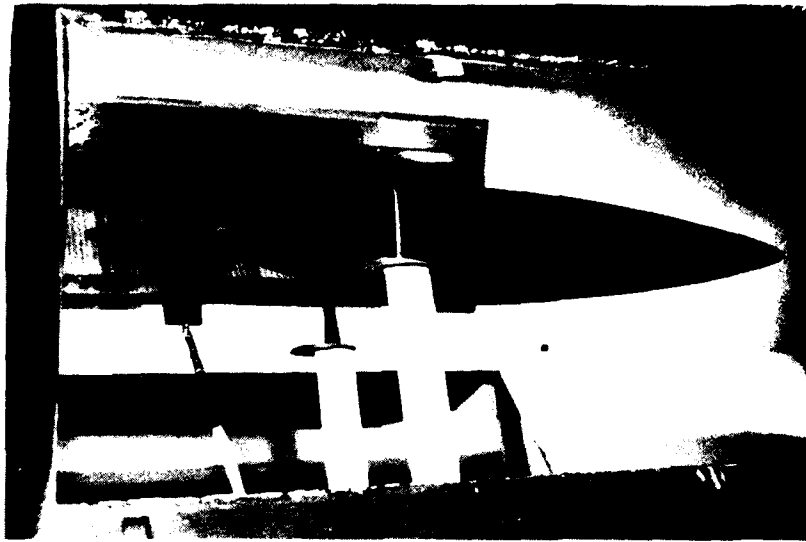
Figure 4.   AEMT hull model mounted to two support forks by an offset trunnion.
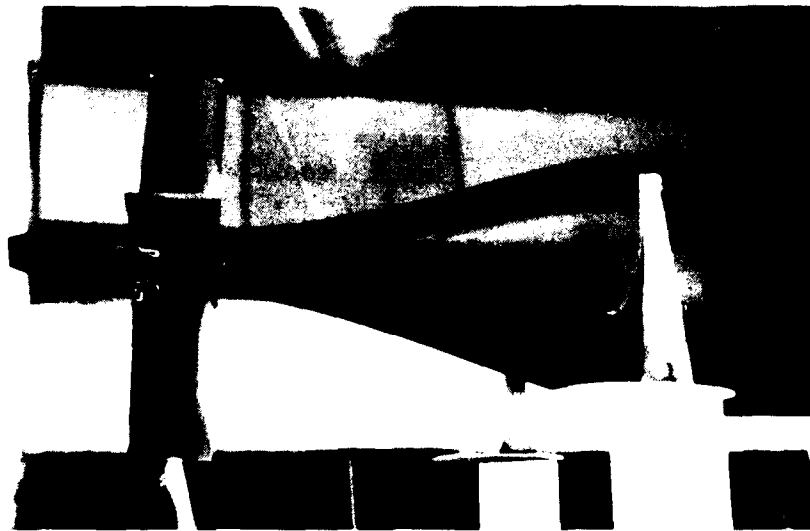
Figure 5.   Close-up of the mounting shown in Figure 4.
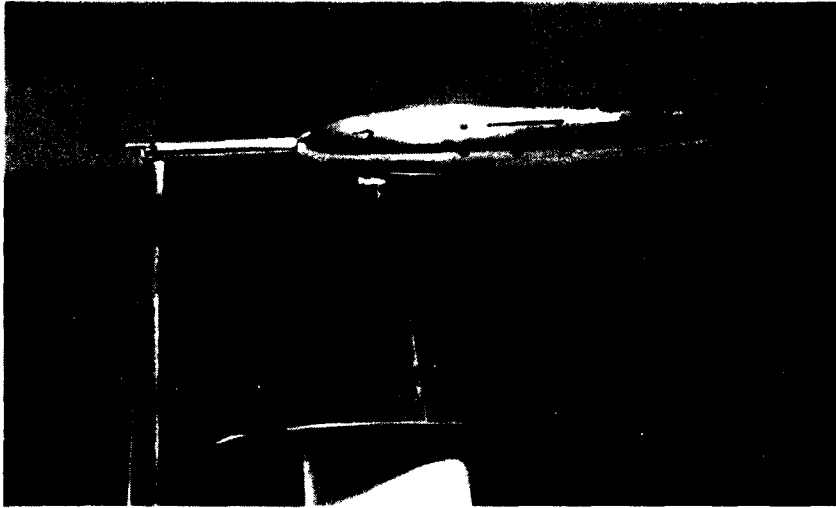
*Figure 6.   Ellipsoidal support, adapted to .... for
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4.3 Powered Model

For the powered model testing (Fig. 7), a high speed dc motor
(Dremel Model No. 280, Series 66-2, with the rectifier removed) was
installed inside the hull. This motor was used to turn various candi-
date propellers at speeds up to 25,000 rpm. The propeller speed was
monitored by an internal electronic tachometer developed for use during
later field trials, as well as by a Strobotac. Power for the motor and
instrumentation was provided by running wires through the hollow support
trunnions and taping them to the trailing edge of the nonmetric portion
of the main support forks. Thus, a portion of the wiring contributed to
the tare drag of the test setup.

4.4 Rake Installation and Yaw Head

The total pressure and static pressure in the hull boundary layer
and in the wake were measured with a 12-tube rake (Fig. 8). Eight of
the tubes measured total pressure and four were Pitot-static tubes. The
same rake had been used in the previous wind tunnel test series at
GALCIT. The rake was attached to a manually read manometer board in
which kerosene was the working fluid.

In addition, a six-tube yaw head was used to survey the tunnel for
flow uniformity, flow angularity, and both the longitudinal and trans-
verse static pressure gradients.
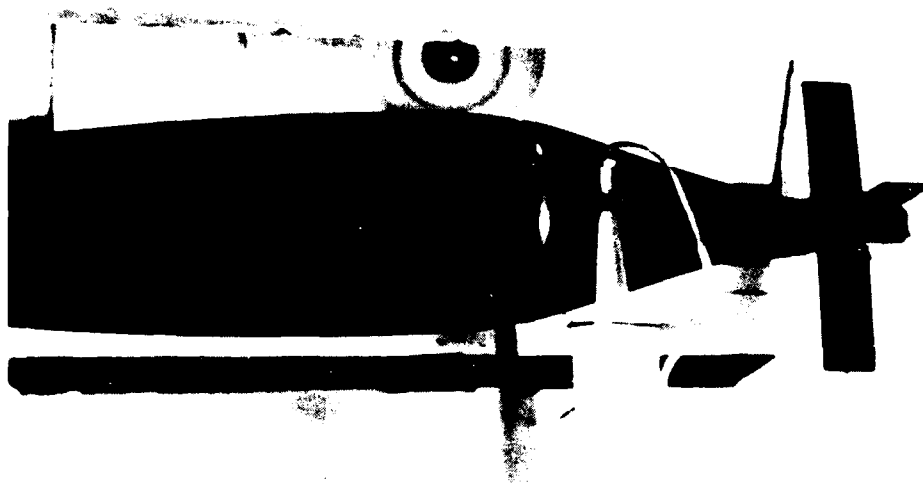
Figure 7. ASTT hull model with high speed dc motor (Dremel Model No. 290, Series 66-2, rectifier removed) used for powered model testing.

Figure 8. Rake measurement on Mod 1 configuration with propeller fit behind a 30° tail cone.

5. TEST PROCEDURES

The wind tunnel test plan[3] called for six classes of tests, each involving a different test procedure. Each test run was identified by a digit designating its class, followed by a period and two more digits indicating the specific run within that particular class. The actual sequence of testing involved intermixing tests from different classes as appropriate to the efficient use of test time. There were 72 runs without turbulence control, and 47 runs using the turbulence control honeycomb.

5.1 Tunnel Survey Tests (0.XX)

The first seven runs were utilized to survey the tunnel with a six-tube yaw head and to evaluate the effectiveness of an array of vortex generators for improving flow attachment in the diffuser section. For the latter work, double tufts of nylon yarn were taped to the diffuser walls. The program schedule did not allow experimentally relocating the vortex generators to improve effectiveness; however, a modest improvement was achieved by bending the generators to reduce their angle of attack.

5.2 Facility Baseline Tests (1.XX)

A total of 14 runs was performed to assess the effect of tunnel turbulence on hull and fin flow conditions. Normal (i.e., low turbulence) flow conditions had been established through flow visualization tests at GALCIT; therefore, the hull and fins were used as "calibrated" indicators of the effective turbulence level in the Venturi tunnel. A wet mixture of kerosene and talc applied with a paint spray gun was used to visualize flow on the hull and fins. A spot trip of plastic tape was located at various longitudinal points along the hull to help determine the transition point; the absence of a turbulent wedge downstream of the trip indicated that transition had already occurred.

Seven runs in this class were used to assess the effectiveness of the turbulence control honeycomb. These runs involved flow visualization on the hull, use of the spot trip, and comparison of the resultant flow patterns with the GALCIT results.

Three runs were used to gather force balance data and additional flow visualization data for evaluating turbulence control. Four runs were used to gather rake data for the same purpose. Data were taken with the rake centered at the aft end of the tail boom in the boundary layer and at several transverse stations vertically off center.

Three runs were utilized to measure the tare drag of the mounts and the electrical wire used in the self-propelled tests. For these runs, the support forks were moved closer together, and the two halves of the support trunnion were pinned together and tied to the pitch arm with a fine wire.

5.3 Fin Characterization Tests (2.XX)

Four runs were utilized to measure the lift, drag, and pitching moment of NACA-0009 fins mounted in the support body. Force balance measurements were taken over an angle of attack range of ±5° at zero flap deflection. Flow visualization photographs were taken at zero angle of attack.

Seven flow visualization runs were used for a side by side comparison of the NACA-0009 fin versus the NACA-16-006 fin at angles of attack ranging from 0 to ±3°. For these runs, a 16-006 semispan was mounted in the right-hand side of the support body, and a -0009 semispan in the left-hand side. Two runs were made with a single 16-006 semispan. Force balance data were recorded on all nine runs.

Six runs were utilized to measure flap effectiveness of the NACA-0009 fins at zero angle of attack. Fixed flap angles ranged from -4.7 to +5.7°. Force balance data were recorded, and a single flow visualization test was made at +5.7°.

Five runs gathered force balance data on two NACA-16-006 semispans over an angle of attack range of ±5°, and for several flap angles at zero angle of attack.

One run was used to measure the lift, drag, and pitching moment of the bare support body at angles of attack ranging from -5° to +6°.

5.4 Static Stability Tests (3.XX)

Time constraints dictated that the planned static stability tests[3] be modified to focus on appropriate fin sizing and the effect of the transition point on static stability. Three runs were made over hull angles of attack covering a nominal range of ±4°. Force balance data were recorded for the bare hull with no horizontal fins, for the fully appended hull, and for the fully appended hull with a spot trip at the nose.

5.5 Propeller Screening Tests (4.XX)

To assess the thrust and torque characteristics of various candidate propellers, force balance data as well as the propulsion motor voltage and current were recorded at a variety of measured propeller speeds during a series of 24 runs. Propellers tested included three two-bladed model hydroplane propellers, and several two- and three-bladed model airplane propellers, with and without modifications. These tests were hampered by shaft vibration problems that limited the choices of propeller speed. Attempts were made to accomplish flow visualization by depositing phenolphthalein on the propeller blades and by introducing a fine spray of aqueous ammonia at the tunnel inlet. These attempts were abandoned after one-half day of unsuccessful effort.

An alternative approach was taken to gather data on flow separation from the propeller blades. This approach involved the introduction of 0.2 in. mesh honeycomb into the propeller inflow (Fig. 9) in an effort to reduce the scale of the turbulence on the blades. Presumably, a sufficiently small-scale turbulence could produce forced turbulent flow on the blades and improve flow attachment.
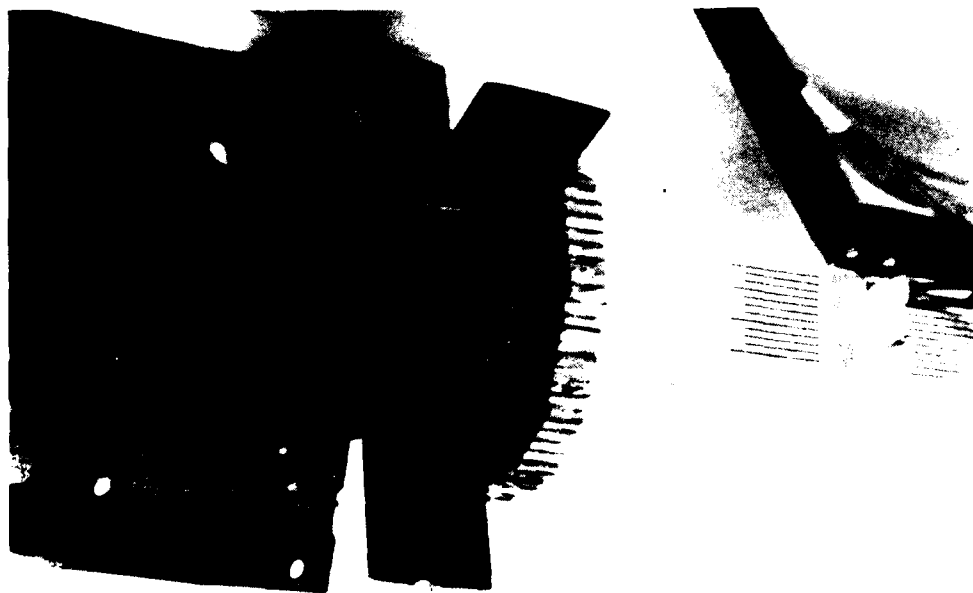
Figure 9. Mesh honeycomb (0.2 in.) fitted to the propeller inflow to reduce scale of turbulence on blades.

In general, the propeller screening tests, for which no data have been reduced, yielded data of doubtful value because the torque measurements were contaminated by a relatively high tare torque. This tare torque resulted partially from the motor design and partially from the sleeve bearing installed to support the propeller shaft. Because of shaft vibration modes this latter torque contribution varied with propeller speed, making it necessary to select test points carefully to avoid a high tare torque. This problem was a direct result of the low thrust levels chosen for the propeller screening tests. The screening tests were terminated with test 4.21, and complete tare torque measurements, with no propeller, were made over a wide range of shaft speeds in test 4.22. Subsequent propeller testing at substantially higher thrust levels was performed in the Powered Model Tests (5.XX).

5.6 Powered Model Tests (5.XX)

Powered model tests, encompassing 22 runs, were actually an extension of the propeller screening tests. Rake measurements in the wake of the powered model were recorded, both on and off axis. Also tested were hub/fairwater options ranging from the original (Mod 0) configuration, through a no-fairwater configuration, to a so-called Mod I configuration that placed the propeller at the downstream end of a 30° tail cone (Fig. 8). All powered model tests were performed in the low turbulence tunnel configuration.

5.7 Field Trial Configuration Checkout (6.XX)

The objectives of this test series were accomplished by the boundary layer rake measurements made in the Facility Baseline Tests (1.XX), which were taken at the Pitot tube location planned for field trials. This series was therefore deleted from the test program.

6. DATA REDUCTION

6.1 Force Balance Data

The data reduction equations for the force balance, as supplied to all users of the tunnel, are:

$$L = 0.9986\ L_r + 0.00067\ D_r + 0.00002\ M_r$$

$$D = 0.00036\ L_r + 1.00355\ D_r - 0.00018\ M_r$$

$$M = 0.0012\ L_r - 0.0004\ D_r + 0.9960\ M_r$$

$$L_r = 10\ L_i$$

$$D_r = D_i$$

$$M_r = 100 \, M_i,$$

where

$\quad$ L $\quad$ = true lift, in grams

$\quad$ D $\quad$ = true drag, in grams

$\quad$ M $\quad$ = true pitching moment, in gram-centimeters

$\quad$ L_r = apparent lift, in grams

$\quad$ D_r = apparent drag, in grams

$\quad$ M_r = apparent pitching moment, in gram-centimeters

$\quad$ L_i = indicated lift as read from balance, in grams

$\quad$ D_i = indicated drag as read from balance, in grams

$\quad$ M_i = indicated pitching moment as read from balance, in gram-centimeters.

As a rule, reference data at zero tunnel q were recorded at the beginning and at the end of a given run. The readings did not always repeat, and occasionally a run was repeated for this reason. This situation resulted from chronic problems with the automatic beam balance that were caused by the mechanical contacts of the servo system. These contacts were cleaned occasionally with alcohol, but the drag balance in particular frequently displayed significant hysteresis.

6.2 Tunnel Dynamic Pressure

The Venturi tunnel is equipped with a q-piezometer that measures the static pressure at the entrance to the test section but is calibrated to indicate the dynamic pressure at that station. The nominal calibration of the q-piezometer, as supplied to tunnel users, is

$$q = 0.89 \, q_i + 1.36,$$

where

$\quad$ q $\quad$ = true dynamic pressure, in pounds per square foot

$\quad$ q_i = indicated dynamic pressure, in pounds per square foot.

It should be noted that, after the initial tunnel survey, the yaw head was used routinely as an auxiliary source of tunnel dynamic pressure data.

After installation of the turbulence control honeycomb, a new survey of the tunnel was made (6/14/79), but the q-piezometer continued to be used for convenience. The survey consisted of a ten point vertical traverse at a station 1 in. downstream of the entrance to the test section to determine the true dynamic pressure at the entrance of the empty test section. The traverse showed an average pressure of 9.58 psf vs an indicated pressure of 13.5 psf on the piezometer. Essentially all of the data with the turbulence-control honeycomb installed were taken at the piezometer reading of 13.5 psf.

6.3 Yaw Head

In the data sheets, the yaw head location is given in (x,y,z) coordinates. The origin of the coordinate system is the tunnel center at the downstream end of the test section; a positive x is upstream, a positive y to the right facing the wind, and a positive z downward. The yaw head dynamic pressure calibration equation is

$$q = 1.023 (P_t - P_s),$$

where

P_t = total pressure

P_s = static pressure.

6.4 Wake Rake

In recording the location of the rake, the longitudinal position of the tips of the nine total-pressure tubes was used as a reference. Therefore, the tips of the four Pitot-static tubes were located 0.25 in. forward of the reference. Transverse location was indicated by noting the distance from the surface of the hull or the distance off the vehicle centerline of either the No. (5,1) or the No. (16,4) Pitot-static tube, as appropriate. Tube numbering is shown graphically on the manometer data sheets in the appendix. Tube Nos. 1 through 4 are static ports.

The center-to-center spacing of the tubes, in inches, as measured upon completion of testing was:

Tube Number	Spacing (in.)
5,1 to 6	0.110
6 to 7	0.113
7 to 8,2	0.124
8,2 to 9	0.117
9 to 10	0.121
10 to 11	0.131
11 to 12,3	0.123
12,3 to 13	0.133
13 to 14	0.117
14 to 15	0.129
15 to 16,4	0.121

Analysis of the (potential flow) static pressure error introduced by the proximity of an adjacent total-pressure tube to a static port indicated a maximum error of -0.00077 in the static pressure coefficient, a negligible quantity. Because the static ports were four diameters downstream of the tip of the Pitot-static tubes, tip and stem errors for those tubes should be negligible.[4] The closest spacing between the centerline of a tube and a solid boundary was 0.09 in. for a tube of 0.0625 in. diam. Reference 4 indicates an error in velocity measurement of less than 0.1% under this worst-case condition.

6.5 Manometer

The specific gravity of the manometer fluid (kerosene) was determined from theory to vary with temperature as follows:

Temperature (°F)	Specific Gravity
70	0.795
73	0.794
75	0.793
78	0.792
80	0.791
82	0.790

The reference for specific gravity was the specific weight of distilled water at 4°C (39.2°F), or 62.427 lb/cu ft. A typical computation of the dynamic pressure at an air temperature of 75°F would be

$$q_n = \left(\frac{h_n - h_{sn}}{12} \right) (62.427 \text{ S.G.}) (\cos \theta) \text{ psf} \quad ,$$

where

h_n = measured height above a zero reference of meniscus of manometer fluid in total-head tube, in inches

h_{sn} = measured height above zero reference of meniscus of manometer fluid in static-head tube (may be obtained by interpolation between static head tubes), in inches

q_n = dynamic pressure at n^{th} total-head tube

S.G. = specific gravity of manometer fluid at given air temperature

θ = manometer board inclination angle, from vertical, ordinarily 30°.

In most of the manometer data, the zero reference was atmospheric pressure. However, in some wake runs with the self-propelled vehicle, it became necessary to shift the zero reference by an arbitrary amount to facilitate the measurements. In a few cases, this shift flawed the data by introducing reference errors. These reference shifts did not affect the measurement of dynamic pressure, but did directly influence the measurement of the static pressure coefficient.

6.6 Propeller Characteristics

6.6.1 Propeller Shaft Torque

The torque delivered to the propeller shaft was computed from the armature current and terminal voltage of the propulsion motor by using the results of previous dynamometer tests. Data prior to 14 June 1979 used the relationship

$$Q = 5.50 (I - 0.2115 - 4.764 \times 10^{-4} V) \quad ,$$

where

I = armature current in amperes

Q = shaft torque in ounce-inches

V = terminal voltage in volts.

For the tests of 14 June 1979 only, which utilized a substitute motor, the following relationship was used:

$$Q = 5.23 \ (I - 0.2115 - 4.764 \times 10^{-4} \ V) \quad .$$

6.6.2 Propeller Thrust

The thrust computation is simply

$$T = D_o - D \ ,$$

where

D = true drag of hull with operating propeller

D_o = true drag of hull with propeller removed but hub in place

T = thrust.

6.6.3 Thrust and Torque Coefficients

The propeller thrust and torque coefficients are defined, respectively, by

$$T_c = \frac{T\lambda^2}{2\pi q_\infty R^2}$$

and

$$Q_c = \frac{Q\lambda^2}{2\pi q_\infty R^3} \ ,$$

where, in consistent units,

Q = torque

q_∞ = free-stream dynamic pressure, i.e., tunnel q including solid blockage correction

R = propeller tip radius

T = thrust

and

$$\lambda = \frac{U_\infty}{\Omega R}$$

where

U_∞ = free-stream velocity

$\Omega = \dfrac{2\pi n}{60}$ rad/s

n = propeller speed, in revolutions per minute.

The parameter λ is the "apparent" advance ratio based on the free-stream velocity rather than on the somewhat more nebulous "true speed of advance."

6.7 Tunnel Corrections

6.7.1 Solid Blocking

An experimental solid blocking correction was obtained by averaging the entrance dynamic pressure at eleven yaw head survey points with an empty tunnel, and then comparing the result with an average of the dynamic pressure at five survey points with the hull model installed. The dynamic pressure ratio was 1.04, implying a velocity ratio of 1.02. This experimental solid blocking correction agrees with the empirical result of Reference 3, which for the present case gives a velocity ratio of 1.017. In the data reduction, the experimental correction of 1.04 was applied to dynamic pressure.

6.7.2 Buoyancy

A longitudinal survey of the static pressure variation along the tunnel centerline (Manometer Data Sheet No. 16-B in the appendix) gave an average gradient of -0.41 psf/ft at a true dynamic pressure of 9.58 psf. Applying this gradient to the hull yielded a drag increment of +0.123 lb, or a drag coefficient increment of +0.0283. Accordingly, a buoyancy correction of +0.0283 was applied to hull drag coefficient measurements with the turbulence control honeycomb installed. The drag coefficient of the basic hull is about 0.02, introducing the possibility of rather large errors in hull drag coefficients obtained from force balance data. In view of this, the hull drag coefficient of 0.01648 computed from the wake velocity defect, must be considered more accurate (see Section 7.7).

6.8 Mount Tare

Mount tare drag consists of the drag of the metric portions of the two main forks, the drag of the pitch arm and the drag of the exposed propulsion wiring, when used. The measured drag of all these elements at q = 9.58 in the low turbulence configuration was 90.5 g. In taking

this measurement, an allowance of 3.0 g was made for the fine wire used to tie the trunnion to the pitch arm. Removing the electrical wire reduced the drag by 13 g. Expressed as an equivalent hull drag coeffi-cient, the mount tare is:

$$\Delta C_{dv} = 0.0397, \text{ without electrical wire,}$$

and

$$\Delta C_{dv} = 0.0464, \text{ with electrical wire,}$$

where C_{dv} is the hull drag coefficient referenced to hull volume to the 2/3 power. Because the basic hull drag coefficient is about 0.02, the use of a conventional fork-type mount introduces the possibility of large errors in drag measurements on a low-drag hull. As noted in the preceding section, these large corrections suggest using the alternative technique of wake survey for hull drag measurements.

In the high turbulence configuration, the mount tare drag without electrical wires was measured to be 131.5 g at 16 psf, giving a mount tare of

$$\Delta C_{dv} = 0.0403, \text{ without electrical wire.}$$

The tunnel turbulence level has no measurable effect on mount tare owing to the low Reynolds number on the mount components.

7. REDUCED DATA

7.1 Flow Visualization

Figure 10 presents the flow pattern on two semispans of the NACA-0009 fins taken during run 2.03, at 16.05 psf and zero angle of attack, in the high turbulence tunnel configuration. Laminar flow exists up to the laminar separation point, typically at approximately 75% of chord. This separation is due to the low chord Reynolds number on the fin. The pattern is strikingly similar to the fin separation pattern depicted in Figure 12 of Reference 1 for a q of 7.7 psf in the low turbulence GALCIT tunnel.

Figure 11 presents the results of a side-by-side comparison of the original NACA-0009 fin (port semispan) with the candidate NACA-16-006 fin (starboard semispan) during run 2.05 at 16.05 psf and zero angle of attack. At zero angle of attack, the 16-006 fin is characterized by sharply defined delayed laminar separation which is consistent with what would be expected on the basis of the static pressure characteristics of the section. The separation point is 83% to 85% of chord.

Figure 10. Flow pattern on two semispans of NACA-0009 fins; run 2.03, 10.05 psf, zero angle of attack, high turbulence tunnel configuration.

Figure 11. Side-by-side comparison of NACA-0009 fin (port semispan) with NACA-16-006 fin (starboard semispan); run 2.05, 10.05 psf, zero angle of attack.

Figure 12 presents the preceding comparison at a +2° angle of attack during run 2.07. The separation point on the port (NACA-0009) semispan has moved well forward to approximately 50% of chord. The separation point on the starboard (NACA 16-006) semispan has also moved forward, but is much less defined. This lack of definition suggests a very thin separated region with an almost uniformly distributed incipient separation condition.

Figure 12. Comparison of NACA-0009 fin (port semispan) with NACA-16-006 fin (starboard semispan); run 2.07, +2° angle of attack.

Figure 13 is from run 2.08, which was a repeat of Run 2.07, but
with a very heavy coat of kerosene/talc to bring out the leading edge
bubble on the 16-006 semispan. The leading edge bubble is sharply
defined and constrained to a very small chordwise dimension of approxi-
mately 0.1 in. The pattern over the remainder of the semispan supports
the interpretation of uniformly incipient separation.

*Figure 13. Same as Figure 12, but with a very heavy coat of kerosene/talc
to bring out the leading edge bubble on the 16-006 semispan.*

7.2 Hull Flow Visualization

Figure 14, from run 1.12, shows the characteristic turbulent wedge generated by a tape spot trip after the installation of the turbulence control honeycomb. Figure 15, from run 1.10, shows the trunnion attachment point to be sufficiently far aft on the hull to minimize premature transition. Figure 16, from run 1.11, shows the well defined turbulent reattachment point on the afterbody. The highly reflective area immediately upstream of reattachment is interpreted as a laminar bubble that extends forward almost to maximum diameter. In this region, the kerosene/talc mixture was observed to migrate slowly downstream without drying, and tended to pile up at the reattachment boundary. Figure 16, taken at 10 psf, bears a striking similarity to Figure 8 of Reference 1 taken at 7.7 psf.

7.3 Fin Lift and Drag Coefficients and Flap Effectiveness

Figure 17 graphically compares the lift and drag coefficients of the two fin sections tested. The open circles apply to the NACA-0009 fins at 16 psf in the high turbulence tunnel. The closed circles apply to the NACA-16-006 fins in the low turbulence tunnel.

Analysis of the data from runs 2.15 through 2.19 and runs 2.20 through 2.24 at zero angle of attack yielded a flap effectiveness factor, $\Delta\alpha/\Delta\delta$, of 0.15 $\pm$0.02 for flap deflections (δ) less than 9°.

7.4 Static Stability Characteristics

Figure 18 compares the pitching moment for the unappended hull (open squares) and the pitching moment with fins. Included is a run in which the flow was tripped at the nose to assess the effect of fully turbulent hull flow on static stability. Note that a large shift (1.9 x 10^{-3} g-cm) in tare pitching moment has been removed from the data for run 5.20 to facilitate comparison.

7.5 Hull Boundary Layer Velocity Profiles

Figures 19, 20, and 21 present the boundary layer velocity profiles at the end of the tail boom (X/L = 1.0) for three q's in the high turbulence tunnel.

Figure 22 presents the boundary layer velocity profile at X/L = 0.99 for a q of 9.97 psf in the low turbulence tunnel.

Figure 23 shows the boundary layer velocity profile at the fin's leading edge (X/L = 0.92) under conditions of natural transition in the low turbulence tunnel. Figure 24 applies to identical conditions except that the flow was tripped to turbulent at the nose.

Figure 14.   Characteristic turbulent wedge generated by a tape spot trip after installation of turbulence-control honeycomb.

Figure 15.   Flow visualization at transition of adverse effect of the ball; row .10.
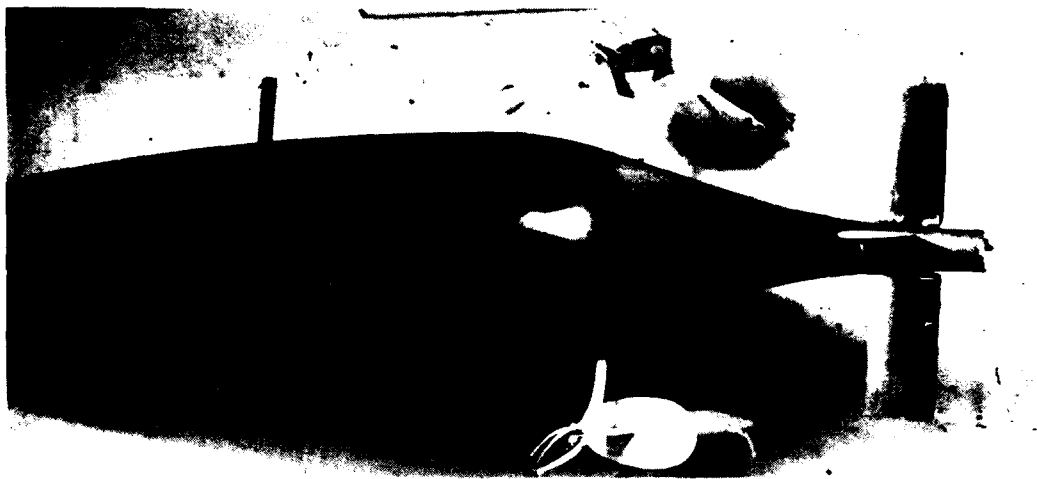
Figure 16. Afterbody flow visualization showing laminar bubble region forward of turbulent reattachment; run 1.17.

O—NACA 0009 FINS
RUN 2.01, q = 16.0 psf
●—NACA 16-006 FINS
RUN 2.20, q = 9.58 psf
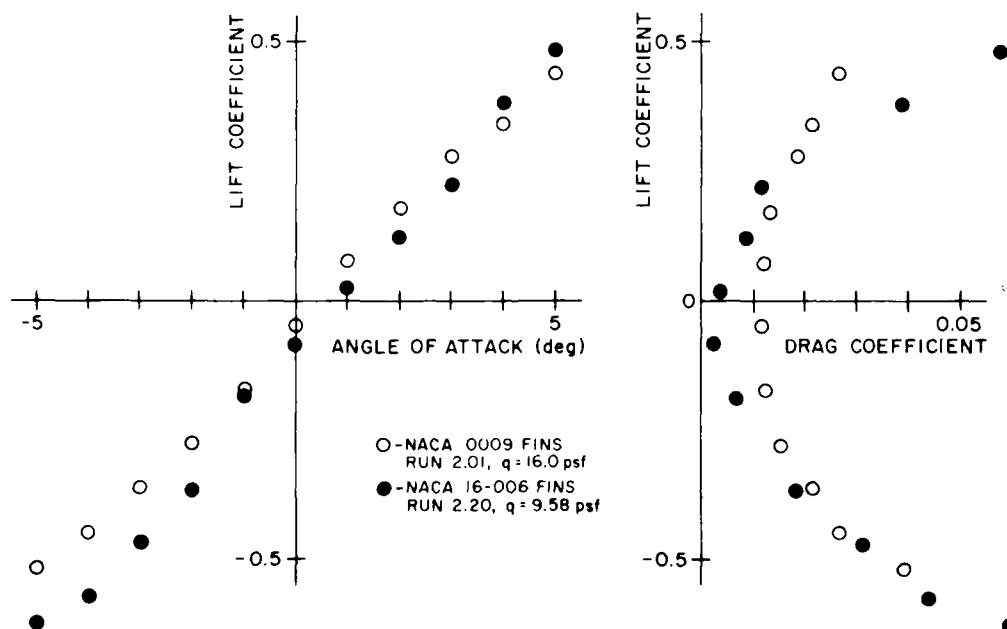
Figure 17. Comparison of fin characteristics.
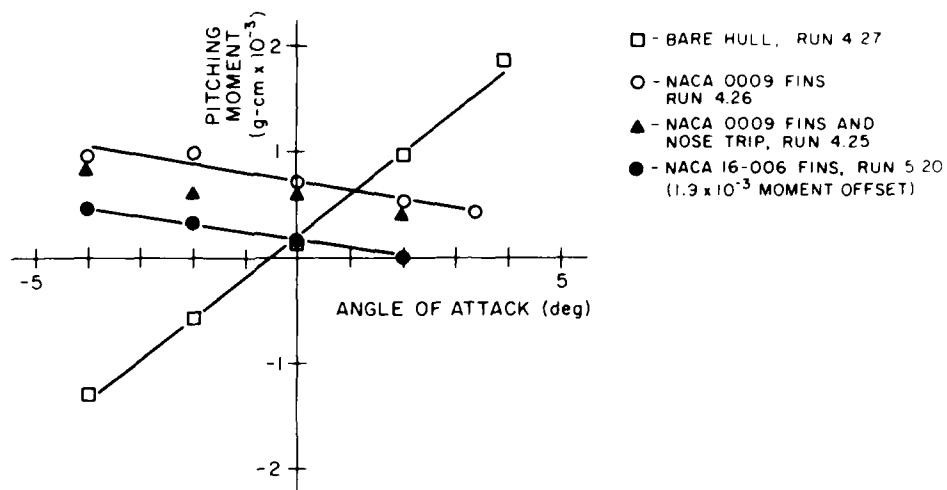
Figure 18. Static stability characteristics in the low turbulence tunnel at q = 9.77 psf.
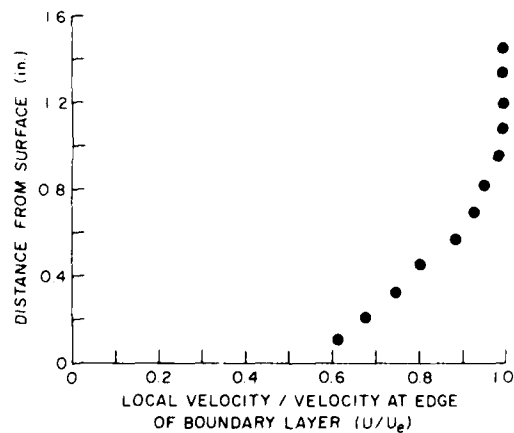
Figure 19. Boundary layer velocity profile at tail (X/L = 1.0); high turbulence tunnel, q = 8.9 psf, run 1.09, natural transition.
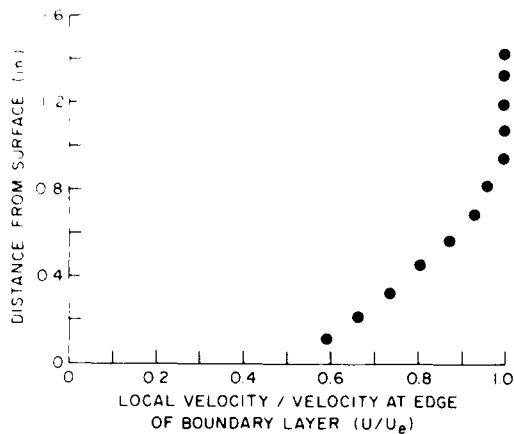
Figure 20.

Boundary layer velocity profile at tail
(X/L = 1.0); high turbulence tunnel,
q = 12.0 psf, run 1.10, natural transition.
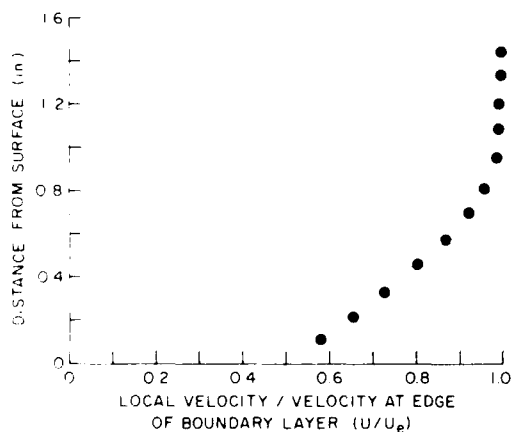
Figure 21.

Boundary layer velocity profile at tail
(X/L = 1.0); high turbulence tunnel,
q = 16.0 psf, run 1.11, natural transition.
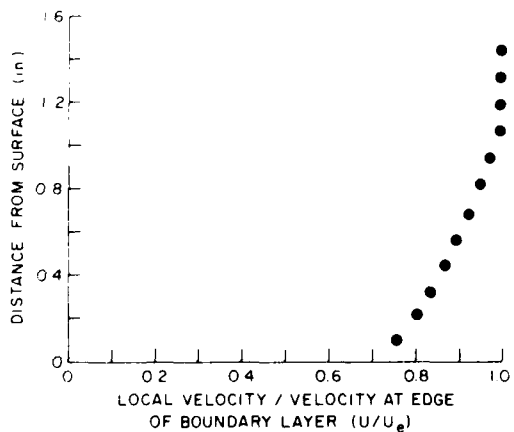
Figure 22.

Boundary layer velocity profile at tail
(X/L = 0.99); low turbulence tunnel,
q = 9.97 psf, run 1.15, natural transition.
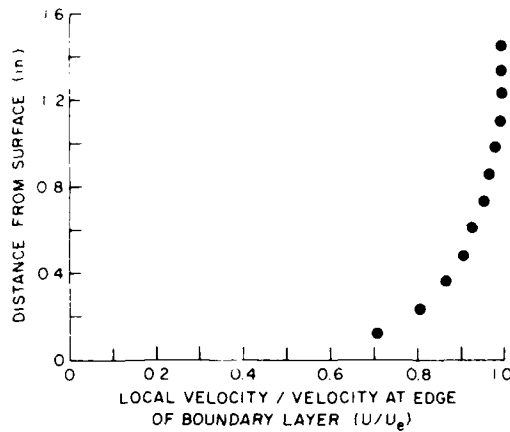
Figure 23.

Boundary layer velocity profile at leading edge of fin (X/L = 0.92); low turbulence tunnel, q = 9.97 psi, run 1.20, natural transition.
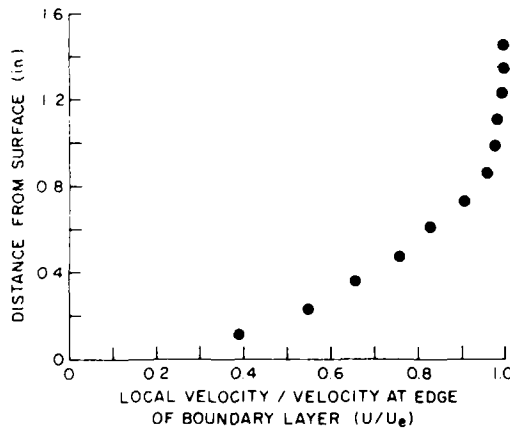
Figure 24.

Boundary layer velocity profile at leading edge of fin (X/L = 0.92); low turbulence tunnel, q = 9.97 psf, run 1.21, flow tripped at nose.

7.6 Propeller Data

Table I lists the propellers tested and the key installation details. Table II presents selected reduced data which also appear in graphical form in Figures 25 through 34.

Table 1. Propellers included in powered model tests.

MFG. MODEL	TYPE	COLOR	NO. OF BLADES	DIAM. (in.)	PITCH (in.)	HUB/FAIRWATER CONFIGURATION			SPECIAL NOTES
						None	Mod 0	Mod 1	
Grish Bros. "Tornado"	Airplane	Yellow	3	5.6	5.1	5.07, 5.08	4.23, 4.24 5.05, 5.06 5.01, 5.02	--	Honeycomb in inflow on 5.05 and 5.06
Grish Bros. "Tornado"	Airplane	Yellow	3	5.6[a]	5.1	5.09, 5.10	--	--	
Grish Bros. "Tornado"	Airplane	Yellow	3	5.6	4.0	5.11, 5.12	--	5.24	
Grish Bros. "Tornado"	Airplane	Yellow	3	5.6[a]	4.0	5.13	--	5.23	
Grish Bros. "Tornado"	Airplane	Yellow	6	5.6[a]	5.1	5.14	--	--	Tandem three-bladed propellers
Octura 2.8	Hydroplane	Black	2	2.76	5.03	5.15, 5.16	5.17, 5.18	5.19, 5.21	
Octura 1270	Hydroplane	Yellow	2	2.76	3.27	--	--	5.25	
Graupner P-55	Hydroplane	Red	2	2.0	2.16	--	--	5.22	
---	Airplane	Grey	2	4.5	2.0	--	--	5.26	

[a]Clipped from 5.6 in. diam propeller

Table II. Reduced data for selected propellers in low turbulence tunnel.

Run No.	T (g)	n (rpm)	λ	$T_c \times 10^3$	$Q_c \times 10^3$	η_p
4.25	-54.4	1,500	2.573	-224.1	-26.99	--
	-107.4	9,350	0.413	-11.37	-0.491	--
	-84.4	12,300	0.306	-4.91	-0.130	--
	-47.4	14,290	0.270	-2.14	0.137	--
	-24.4	15,250	0.252	0.975	0.335	--
	4.6	16,200	0.239	0.161	0.489	0.078
	34.6	17,110	0.225	1.09	0.607	0.405
	60.6	17,880	0.216	1.76	0.718	0.528
	80.6	18,610	0.207	2.14	0.810	0.548
4.25	115.6	19,380	0.199	2.83	1.01	0.556
5.01	-106.4	5,100	0.752	-37.4	-2.99	--
	-135.4	9,500	0.412	-14.1	-0.776	--
	-88.4	13,990	0.274	-4.14	-0.112	--
	-57.4	14,860	0.258	-2.38	-0.123	--
	-35.4	15,800	0.243	-1.29	0.307	--
	-11.4	16,630	0.231	-0.375	0.455	--
	18.6	17,570	0.218	0.551	0.568	0.212
	45.6	18,050	0.212	1.22	0.691	0.373
	65.6	18,630	0.206	1.74	0.797	0.449
	87.6	19,260	0.199	2.16	0.878	0.489
5.01	99.6	19,630	0.196	2.38	0.978	0.476
5.05	-94.0	9,000	0.428	-10.7	-0.838	--
	-44.0	13,200	0.292	-2.32	0.022	--
	-5.0	14,790	0.261	-0.213	0.360	--
	12.0	15,580	0.251	0.458	0.530	0.214
	16.0	16,400	0.236	1.58	0.669	0.556
	59.0	17,040	0.226	1.88	0.792	0.539
	81.0	17,810	0.216	2.34	0.883	0.573
5.05	120	18,900	0.204	3.10	1.08	0.588
5.08	-86.0	14,100	0.271	-3.92	-0.116	--
	-31.0	16,140	0.258	-1.09	0.294	--
	18.0	17,100	0.223	0.557	0.593	0.209
	69.0	19,100	0.200	1.74	0.750	0.465
5.08	120.0	20,350	0.188	2.61	0.893	0.548

Run No.	T (g)	n (rpm)	λ	$T_c \times 10^3$	$Q_c \times 10^3$	η_p
5.09[a], 5.10	-67.0	12,080	0.318	-10.1	--	
	-5.0	16,140	0.238	-0.425	0.744	--
	41.0	19,500	0.197	2.38	1.10	0.425
	97.5	22,450	0.171	4.29	1.59	0.566
5.09, 5.10	144.00	24,440	0.157	5.35	1.50	0.562
5.11	2.5	10,300	0.374	--	--	
	-17.5	13,200	0.292	-0.925	0.460	--
	28.5	14,540	0.265	1.25	0.854	0.586
	72.5	15,660	0.246	2.72	1.16	0.575
	110.5	16,620	0.232	3.68	1.37	0.616
5.11	167.5	17,600	0.219	5.00	1.56	0.704
5.15	-28.0	9,660	0.811	-0.047	--	--
	16.0	16,130	0.486	9.67	10.2	0.455
	57.0	21,080	0.371	20.1	13.5	0.550
5.15	102.0	24,444	0.320	26.8	15.6	0.550
5.17	-40.4	9,250	0.848	-0.075	-6.95	--
	8.60	17,200	0.456	4.58	8.92	0.229
	58.6	21,689	0.362	15.8	15.6	0.581
5.17	48.6	25,442	0.335	17.3	21.4	0.283
5.21	0.200	11,000	0.710	0.259	0.532	0.544
	30.2	15,380	0.508	20.0	1.22	1.10
	75.2	20,400	0.383	27.4	13.8	0.753
5.21	105.	22,580	0.346	32.2	15.1	0.719
5.24	-64.3	11,000	0.551	-4.93	--	--
	59.7	15,000	0.257	2.44	1.17	0.556
5.24	226	18,400	0.210	6.19	1.83	0.711
5.25	-34.8	11,000	0.715	-45.6	--	--
	-9.80	15,000	0.523	-1.14	0.154	--
	9.20	18,400	0.426	4.24	5.68	0.518
	51.2	22,000	0.357	10.2	5.83	0.627
5.25	55.2	25,000	0.314	13.9	7.72	0.566

[a] $R = 0.2333$ ft was used to compute coefficients for Run 5.09, 5.10
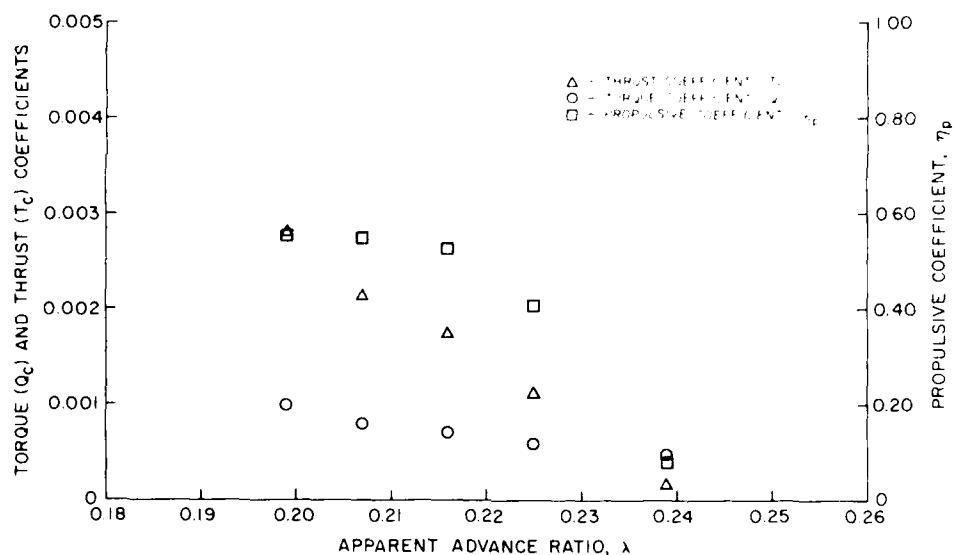
Figure 25. *Propeller characteristics of Grish "Tornado" propeller with 5.6 in. diameter and 3.1 in. pitch; run 4.23 with Mod 0 fairwater configuration and nose trip.*
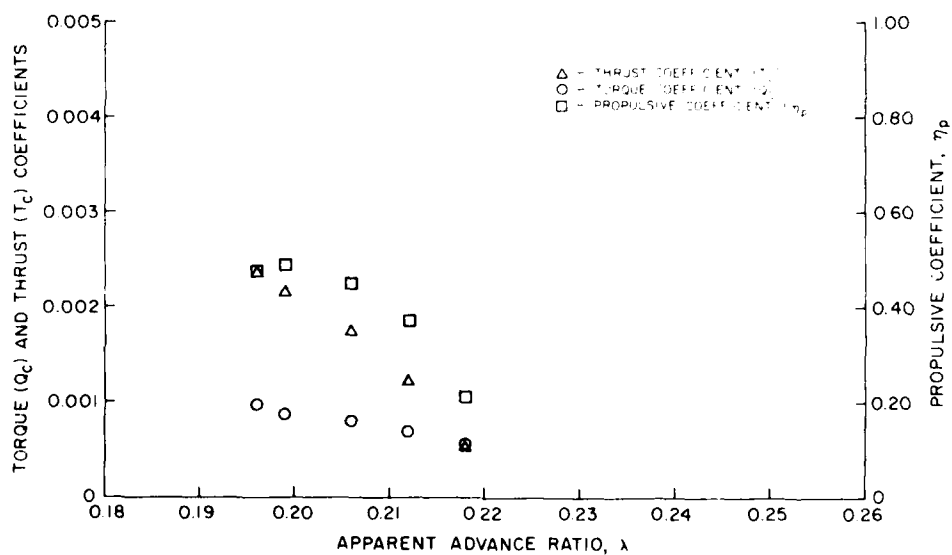
Figure 26. *Propeller characteristics of Grish "Tornado" propeller with 5.6 in. diameter and 3.1 in. pitch; run 5.01 with Mod 0 fairwater configuration.*
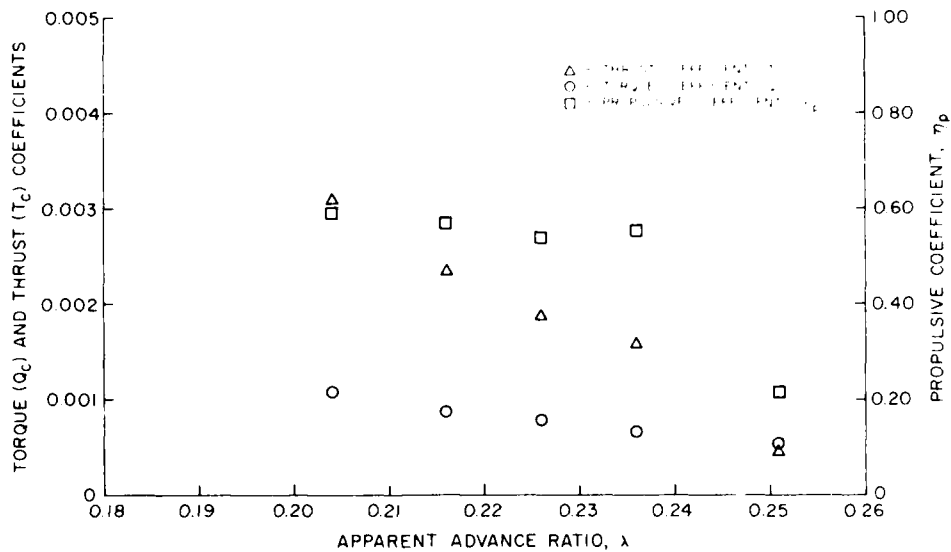
Figure 27. *Propeller characteristics of Grish "Tornado" propeller
with 5.6 in. diameter and 3.1 in. pitch; run 5.05 with
Mod 0 fairwater configuration and tail honeycomb.*
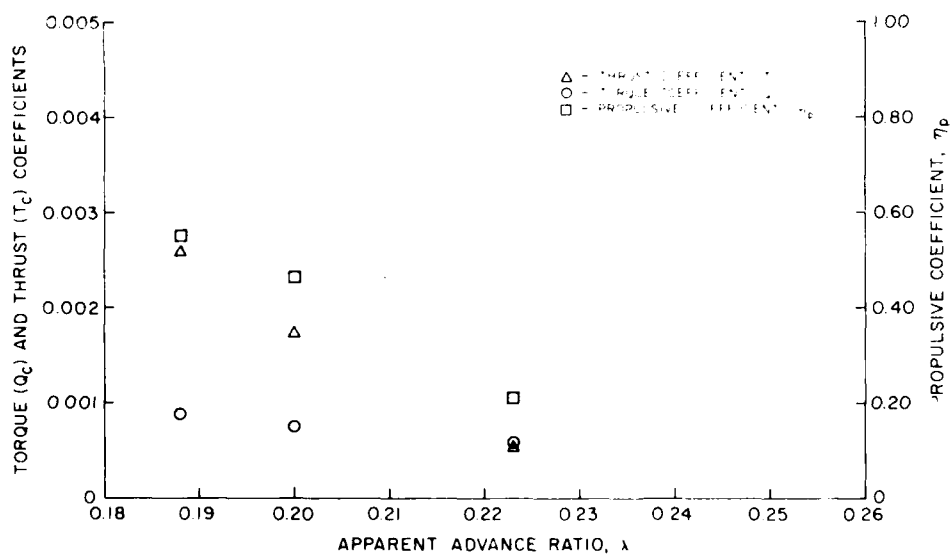
Figure 28. *Propeller characteristics of Grish "Tornado" propeller
with 5.6 in. diameter and 3.1 in. pitch; run 5.08 with
no fairwater.*
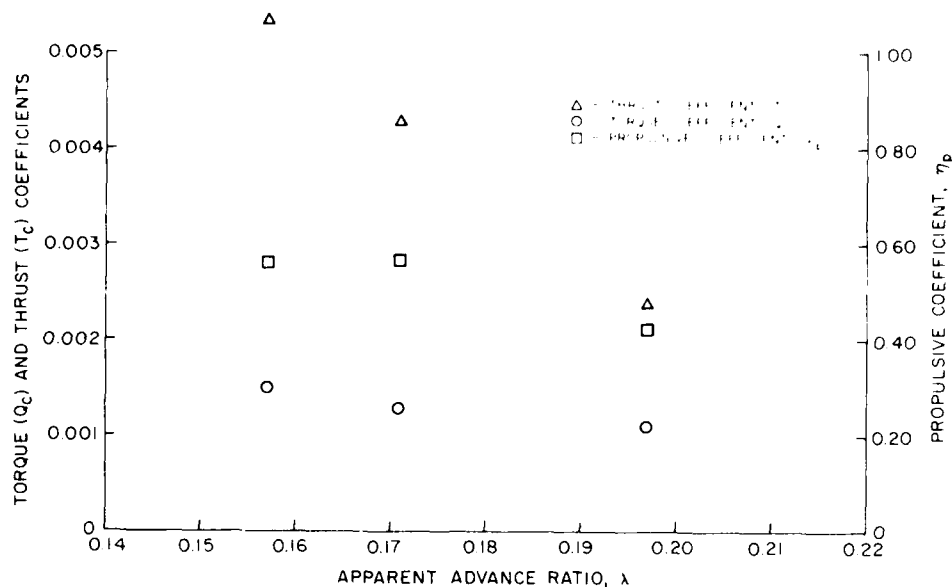
Figure 29. Propeller characteristics of Grish "Tornado" propeller
with 5.6 in. diameter and 3.1 in. pitch clipped to
3.6 in. diameter; run 5.09,5.10 with no fairwater.
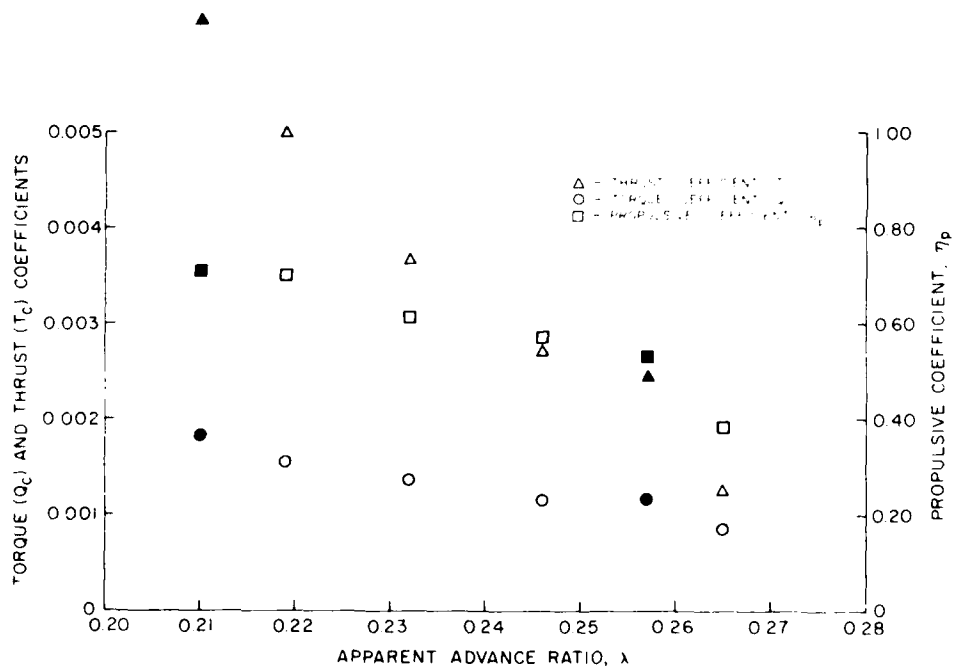
Figure 30. Propeller characteristics of Grish "Tornado" propeller
with 5.6 in. diameter and 4 in. pitch; open symbols:
run 5.11, no fairwater; closed symbols: run 5.24, Mod 1
fairwater.
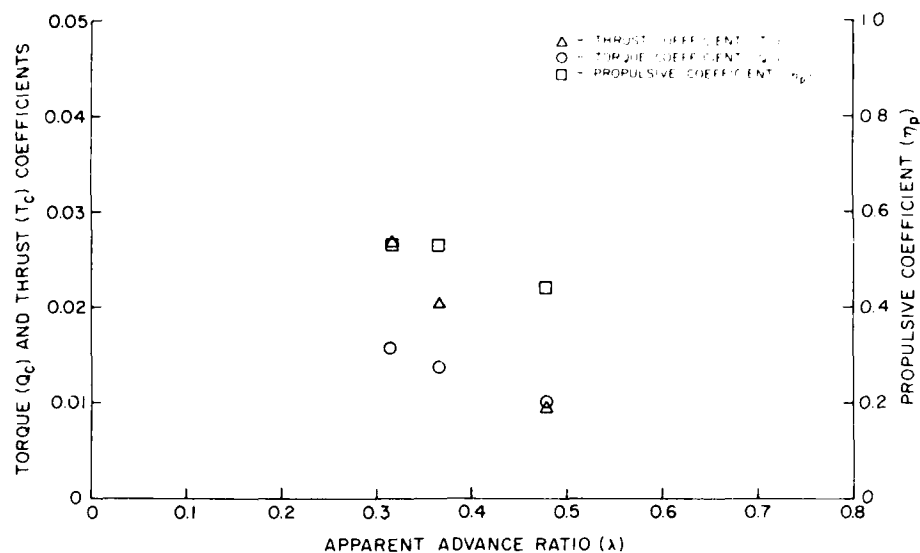
Figure 31. Propeller characteristics; run 5.15 with no fairwater and Octura 2.8 propeller with 2.76 in. diameter and 5.03 in. pitch.
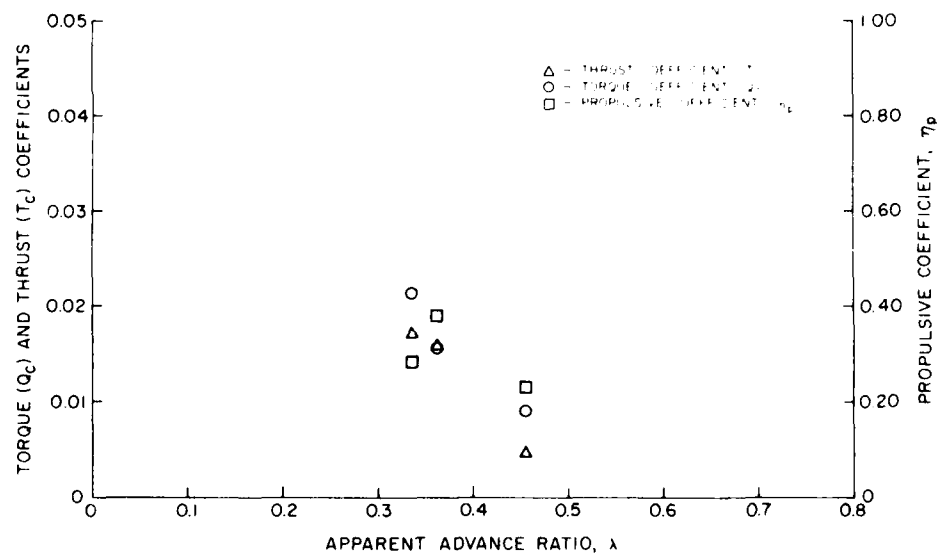
Figure 32. Propeller characteristics; run 5.17 with Mod 0 fairwater and Octura 2.8 propeller with 2.76 in. diameter and 5.03 in. pitch.
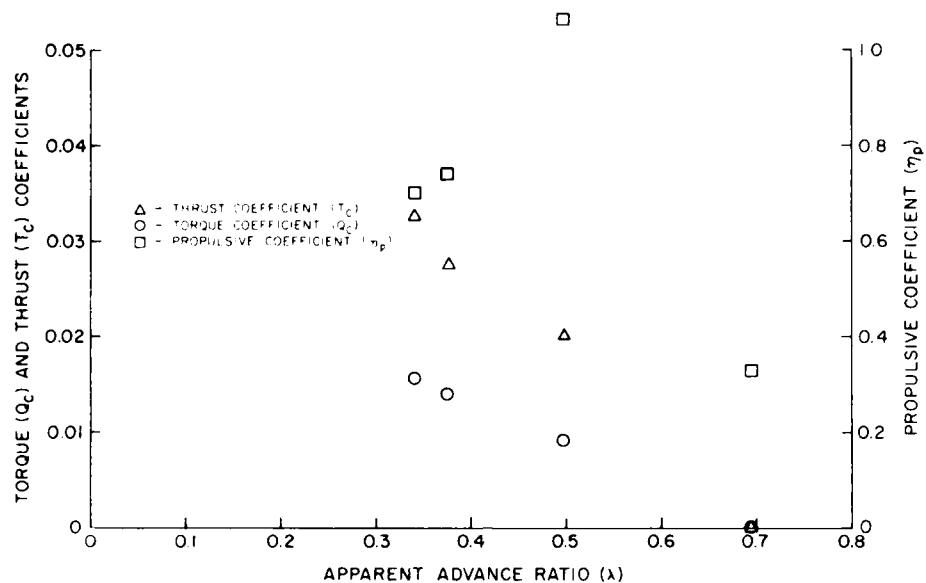
Figure 33.   Candidate propeller characteristics; run 5.21 with Mod I
             fairwater and Octura 2.8 propeller with 2.76 in. diameter
             and 5.03 in. pitch.
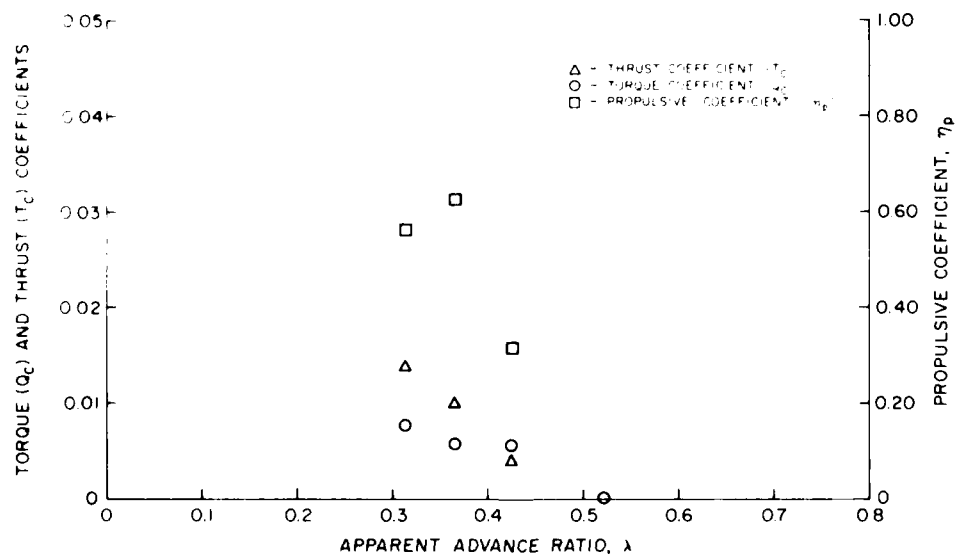
Figure 34.   Candidate propeller characteristics; run 5.25 with Mod I
             fairwater and Octura 1270 propeller with 2.76 in. diameter
             and 3.27 in. pitch.

7.7   Wake Survey Data

Selected wake survey data in the low turbulence tunnel are listed in Table III and are shown in graphical form in Figures 35 through 38. Figure 35 presents the wake velocity profile for the basic hull with no propeller, but with the Mod I hub/fairwater configuration. Figure 35 also presents the hull velocity profile with a honeycomb ring around the tail boom aft of the fins (Fig. 9). Figure 36 presents the velocity profile in the wake of the hull with the Grish 5.6 in. x 3.1 in. propeller in the Mod 0 configuration, turning at 19,500 rpm. Also shown is the velocity profile for the same propeller, turning at the same speed, but with the honeycomb ring positioned in the inflow.

Figure 37 presents the velocity profile in the hull wake with the Octura 2.8 propeller, with no hub/fairwater, turning at 24,400 rpm. These data are almost indistinguishable from those for the Mod 0 hub/fairwater configuration. Also in Figure 37 are wake data for the Octura 2.8 propeller in the Mod I hub/fairwater configuration.

Figure 38 presents the velocity profile behind the hull with the Octura 1270 propeller, in the Mod I configuration, turning at 22,000 rpm. The only significant difference in geometry between this propeller and the Octura 2.8 is the pitch.

Graphical integration of the wake velocity deficit for the clean hull in Figure 35 yielded a hull drag coefficient of 0.01648 for an equivalent speed of 4.6 kn in fresh water.
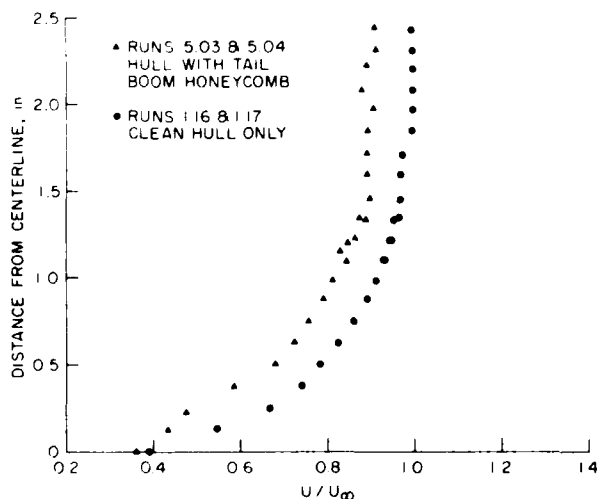
Figure 35.

Wake velocity profile for AEMT hull with Mod I hub/fairwater configuration and no propeller.

RUNS 5 05 & 5.06
HULL WITH TAIL
BOOM HONEYCOMB

RUNS 5 01 & 5.02
CLEAN HULL ONLY
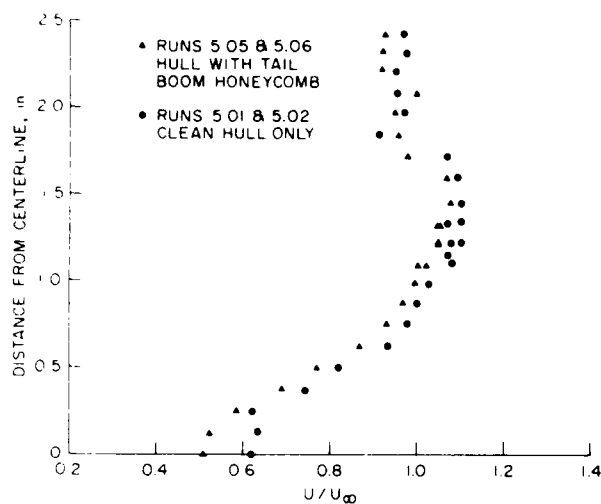
Figure 36.

Wake velocity profile for AEMT hull with Grish propeller and no hub/fairwater. n = 19,500 rpm; λ = 0.195.

RUN 5.16
NO HUB / FAIRWATER

RUN 5.21
MOD I HUB / FAIRWATER
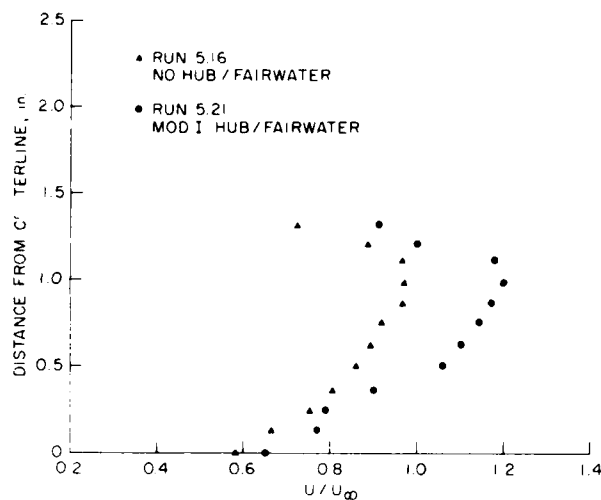
Figure 37.

Wake velocity profile for AEMT hull with Octura 2.8 propeller. Run 5.16: n = 24,400 rpm; λ = 0.364. Run 5.21: n = 22,580 rpm; λ = 0.342.

RUN 5 25
MOD I HUB / FAIRWATER
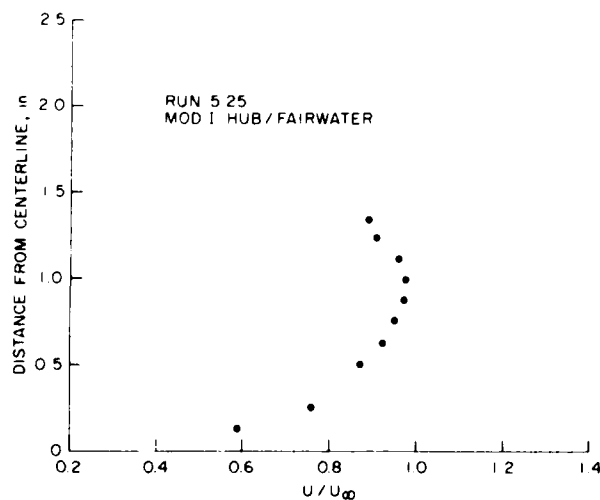
Figure 38.

Wake velocity profile for AEMT hull with Mod I hub/fairwater and Octura 1270 propeller. n = 22,000 rpm; λ = 0.551.

Table III. Reduced data; wake velocity profile at q = 9.79 psi.

Run No.	y (in.)	$\frac{U}{U_\infty}$	Notes	Run No.	y (in.)	$\frac{U}{U_\infty}$	Notes
1.16	0	0.389	Mod I hub/fairwater No propeller	5.04	1.10	0.842	Mod I hub/fairwater Honeycomb ring aft of fins No propeller
	0.121	0.544			1.221	0.830	
	0.250	0.667			1.35	0.875	
	0.367	0.759			1.467	0.894	
	0.500	0.781			1.60	0.891	
	0.625	0.824			1.725	0.922	
	0.754	0.862			1.854	0.891	
	0.875	0.889			1.975	0.905	
	0.992	0.911			2.092	0.879	
	1.116	0.953			2.216	0.884	
	1.229	0.952			2.329	0.912	
1.16	1.339	0.955		5.04	2.439	0.907	
1.17	1.10	0.937	Mod I hub/fairwater No propeller	5.02	0.0	0.622	Grish 5.6" x 5.1" Mod 0 n = 19,500 rpm λ = 0.195
	1.221	0.952			0.121	0.655	
	1.350	0.964			0.25	0.624	
	1.467	0.964			0.367	0.746	
	1.600	0.967			0.500	0.819	
	1.725	0.972			0.625	0.956	
	1.854	0.979			0.754	0.978	
	1.975	0.980			0.875	1.00	
	2.092	0.980			0.992	1.05	
	2.216	0.979			1.116	1.07	
	2.329	0.979			1.229	1.08	
1.17	2.439	0.975		5.02	1.339	1.07	
5.03	0	0.361	Mod I hub/fairwater Honeycomb ring aft of fins No propeller	5.01	1.10	1.08	Grish 5.6" x 5.1" Mod 0 n = 19,500 rpm λ = 0.195
	0.121	0.456			1.221	1.10	
	0.25	0.477			1.35	1.10	
	0.367	0.585			1.467	1.10	
	0.50	0.679			1.60	1.09	
	0.625	0.725			1.723	1.07	
	0.754	0.756			1.854	0.914	
	0.875	0.792			1.975	0.971	
	0.992	0.810			2.092	0.957	
	1.116	0.826			2.216	0.954	
	1.229	0.863			2.329	0.977	
5.03	1.339	0.882		5.01	2.439	0.971	

Table III, continued.

Run No.	y (in.)	$-\dfrac{U}{U_\infty}$	Notes	Run No.	y (in.)	$-\dfrac{U}{U_\infty}$	Notes
5.06	0	0.507	Grish 5.6" x 3.1"	5.21	0	0.651	Octura 2.8
	0.121	0.525	Mod 0 with honeycomb		0.121	0.769	Mod 1 hub/fairwater
	0.25	0.584	ring in inflow		0.25	0.792	n = 22,580 rpm
	0.367	0.691	n = 19,500 rpm		0.367	0.905	λ = 0.342
	0.500	0.775	λ = 0.195		0.500	1.06	
	0.625	0.869			0.625	1.10	
	0.754	0.952			0.754	1.11	
	0.875	0.970			0.875	1.17	
	0.992	0.995			0.992	1.20	
	1.116	1.000			1.116	1.18	
	1.229	1.05			1.229	1.00	
5.06	1.359	1.05		5.21	1.359	0.910	
5.05	1.10	1.02	Grish 5.6" x 3.1"	5.25	0	0	Octura 1270
	1.221	1.05	Mod 0 with honeycomb		0.121	0.591	Mod 1 hub/fairwater
	1.35	1.06	ring in inflow		0.250	0.761	n = 22,000 rpm
	1.467	1.078	n = 19,500 rpm		0.367	0.763	λ = 0.351
	1.60	1.07	λ = 0.195		0.500	0.864	
	1.723	0.975			0.623	0.924	
	1.854	0.962			0.754	0.954	
	1.975	0.951			0.875	0.970	
	2.092	0.999			0.992	0.972	
	2.216	0.922			1.12	0.960	
	2.329	0.924			1.25	0.906	
5.05	2.459	0.933		5.25	1.34	0.889	
5.16	0	0.583	Octura 2.8				
	0.121	0.667	No hub/fairwater				
	0.25	0.737	n = 21,400 rpm				
	0.367	0.802	λ = 0.364				
	0.500	0.862					
	0.625	0.890					
	0.754	0.918					
	0.875	0.967					
	0.992	0.977					
	1.116	0.969					
	1.229	0.888					
5.16	1.359	0.725					
5.21	0	0.651					

8. CONCLUSIONS

As noted in the Introduction, the test goals, involving the acquisition of specific test data, were judged to be accomplished to a degree sufficient to satisfy the overall objectives of the test program. This judgement, of course, is necessarily somewhat subjective in that the adequacy of the data can only be assessed after subsequent analysis and interpretation within the context of the problem to be solved. Nevertheless, it is possible to draw tentative conclusions on the strength of the reduced data with regard to three of the four objectives listed in the Introduction. Specifically, it is concluded that:

(1) Powered model data indicate that the Octura 2.8 propeller in the Mod I configuration has the potential for correcting the problem of low propulsive coefficient. The NACA 16-006 fin choice achieves attached flow over about 85% of chord as desired.

(2) The excellent correlation between the vehicle hull drag measurements in the University of Washington facility and those in the GALCIT facility, in combination with the powered model data gathered in the former facility, provides an excellent basis for predicting vehicle performance in future field trials.

(3) Although the specific cause of low propulsive coefficent was localized to the use of the Web 2.75 propeller, it is impossible to conclude the nature of the deficiency in that propeller from the Venturi wind tunnel tests, since it was not possible to test the propeller at the high rpm's required by a wind tunnel test.

(4) The acquisition of the additional wind tunnel data does contribute to the technology data base for hydrodynamic characterization of the AEMT vehicle.

9. REFERENCES

1. D.J. Warner and W.W. Haigh, AEMT Vehicle Wind Tunnel Test Results, Dynamics Technology Report DT-7912-1, December 1978.

2. APL-UW 8009, An Experimental and Analytical Investigation of the Propulsion Characteristics of the AEMT Low-Drag Underwater Vehicle, R.M. Hubbard, Applied Physics Laboratory, University of Washington, September 1980.

3. Selected Reference Material for APL-UW 8013, Applied Physics Laboratory, University of Washington, October 1980, item 22.

4. A. Pope and J.J. Harper, Low-Speed Wind Tunnel Testing, John Wiley and Sons, New York, 1966.

5. Selected Reference Material for APL-UW 8013, Applied Physics Laboratory, University of Washington, October 1980, item 21.

APPENDIX

	TEST CONDITIONS		CONFIGURATION		PERFORMANCE DATA							FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T_∞ [F]	p_∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [gm]	Lift [gm]/lo	Moment grom/lo	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [I]	COMMENTS
4-15 73			0.01	Bare Tunnel			11.7				1	Diffuser Tuft Pattern	✓			
4-15 73			0.02	"			14.6 to 15.1				1	"	✓			
4-15 73			0.03	"			16.2 to 16.6				1	"	✓			V = 66 I = 64 RPM = 880
4-15 73			0.04	Vortex Gens. at x = 73"			16.3 to 16.5				2	"	✓			V = 66 I = 65 RPM = 870
4-15 73			0.05	V.G's at x = 73"			16.0 to 16.3				3	/				V = 66 I = 66 RPM = 880
"			0.06	V.G's at x = 73"			17.8 to 18.2				1	/				Try max q I = 76 RPM = 920 V = 66
— MAKE VORTEX GENERATORS A PERMANENT INSTALLATION																
4-16 73			0.07	Winged Cylinder		14 16 18					4 5	—	—			Calibration Tunnel survey Flow Visual/Drag

A1

TEST CONDITIONS			CONFIGURATION				PERFORMANCE DATA						FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T∞ [F]	p∞ [psf]	RUN #	MODEL CONFIGURATION	α	δ	q [psf]	b	Drag [gr]	Lift [%]	Moment [gr·in/lb]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
4-22 73			1.00	Original Hull & Fins	0	–	0	–	93.2	153.0	-52.1	1	—	✓			Reduced on Vortex Generators
4-22 "			1.01	"	0	–	16.5	–	38.0	139.0	-54.50	6	—	✓			
4-22 "			1.02	" + Spot Trip Fwd	0	–	16.5	–	–	–	–	6	Total Vehicle	✓			
4-" "			1.03	"	0	–	16.5	–	–	–	–	6	"	✓			
4-22 "			1.04	"	0	–	16.5	–	–	–	–	6	Aft Body	✓			
4-22 "			1.05	Hull + Fins Spot Trip at Max Dia.	0	–	16.5	–	–	–	–	6	Total Vehicle	✓			
4-23 75	0		—	Support Body + 0009 Fins	0	0	0	99	147.5	-31.5		—		✓			Check Zeros
4-23	→		2.01	"	0	16.5	152.5	153	-36		7		✓			
4-23	→		→	"	+10		154	161	-33		—		✓			

TEST CONDITIONS				CONFIGURATION				PERFORMANCE DATA					FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T∞ [F]	P∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	σ	q [psf]	Drag []	Lift []	Moment []	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current []	COMMENTS
4-23	75		201	Support Rod + 0009 Fins	+2	0	0	161.5	155	167.5	-27	1					
					+3				158	174	-24	1					
					+4				161	178	-20.5	1					
					5+				161	184.5	-16.5	1					
					-1				155.5	154	-41	1					
					-2				158	138.5	-45	1					
					-3				162	133	-48	1					
					-4				165.5	127.5	-52	1					
					5-				172	123	-54	4					
	80				0	0	0	0	104.3	146.6	-29.6	—					

End of Run 3
Zero Did not
Repeat !

TEST CONDITIONS			CONFIGURATION				PERFORMANCE DATA					FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T∞ [F]	p∞ [psf]	RUN #	MODEL CONFIGURATION	a	b	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
4-23	78		1	Support Body + 0009 Fins	-		0	102.6	147.0	-29.2	1		(			Dms zero not reliable within ±2 gr
	78		2.02	"	0		16.5	155	152	-36.5	4		(			Repeat 2.01 at α=0
	79		1	"			0	103.6	146.5	-29.1	1					Repeat zero
	79		203	"	0		16.5						✓			Kerosene-talc Flow Visualization
	77		204	Support Body No Fins	0		0	99.0	151.0	-27.4	1					2 errors Tape Removed From Wax Filled Holes
					0		16.5	145	159.2	-33	4					
					+1			146	159.5	-33						
					+2			146.5	159.5	-32.5						
					+3			146	159.5	-32						

A4

TEST CONDITIONS				CONFIGURATION			PERFORMANCE DATA					FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T_∞ [F]	P_∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
4-23			2.04	Support Body No Fins	+4		16.5	147.5	154.5	-32.5						
					+5			147	154.5	-32.5						
					-1			147.5	154.5	-33						
					-2			148	154.5	-33.5						
					-3			148	154.5	-33.5						
					-4			148	159	-34						
18					-5			147	159	-34	7					
							0	980	151.08	-29.4						Zeroes at end of 2.04

DATE	T_∞ [F]	P [psf]	RUN #	MODEL CONFIGURATION	α	β	P	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
4-29-72			1	Support Body + 3.8"-16-006 Rt. 3.6"-0009 Lft.	0			0	98.5	146.2	-21.5			/			Zeroes
			2.05	"	0			16.5					Both Fins	√			
			2.06	"	+3°			16.5					"	√			Leading edge separation bubble on 16-006. No apparent sep. at T.E.
			2.07	"	+2°			16.5					"	√			No L.E. Bubble. Separation well fwd on 0009. 16-006 not wet enough.
			2.08	"	+2°			16.5					wetter coating	√			0009 Sep @ ≈ 1/3 C. 16-006 Incip. Separ'n ≈ 1/8 C to C, ≈ 0.1" L.E. bubble
			2.09	"	+3°			16.5					"	√			16-006 larger L.E. Bubble. 0009 severe separation near root, well fwd.
			2.10	"	+1°			16.5					"	√			No L.E. Bubble. Both fins have comparable separation.
	76		2.11	"	0			16.5	150.0	156.0	-22.0	8		/			

TEST CONDITIONS				CONFIGURATION		PERFORMANCE DATA							FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T_∞ [F]	P_∞ [psf]	RUN #	MODEL CONFIGURATION	α	δ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
4-29			2.11	Support Body + 3.8"φ - MG-006 Pt. 36"φ -0.009 Left	+1		16.5	151.3	161.0	-28	8					
→	78		→		+3		→	158.0	176.0	-44.0						
					+5			169.0	181.0	-72.0						
	80				-1			152.5	147.5	-37.5						
	80				-3			158.0	134.0	-44.5						
	80				-5		→	169.0	125.5	-52.0	→					
						0	0	99	47.0	-27.5						Zeros
			1	Support Body + 3.8"φ-16-006 Pt. Single SemiSpan		0	0	100.0	149.0	-27.0						Zeros
→			2.12	" " "	0	16.5	16.5	158.0	154.0	-31	8					

TEST CONDITIONS				CONFIGURATION				PERFORMANCE DATA				FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	Re [ ]	p∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
4-29	80		2.12	Suspnd body Single Semi Span 16-000 Rt.	+1		16.5	146	160.5	-245	8					
			11	11	+3		16.5	152	167.5	-245	8					
	76		1	Original Hull + Fins (Inactive Prop)	0		0	77	-213	-546.5	8					
			1.06	11 with Spot Trip	0		16.5					Total Body	✓			Apparently Fully Turbulent
			1.07	11	0		16.5					Extra wet coat	✓			11 11
	75		1.08	Original Hull Fins Prop Taped up	0		14.5				8	—	✓			
4-4			1	Original Hull + Fins No Prop	0		0	93.0363	204.5565 (-)(-)	565		—	✓			Zeroes
	77		1.09	11	0		8.5	291	-197.5	568.5	9					
	77		1.10	11	0		12.0363	-194		-570	9					

Test data log sheet (handwritten)

TEST CONDITIONS			CONFIGURATION				PERFORMANCE DATA					FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T_0 [F]	p_0 [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
4-30-78	78		1.11	OrigHull+Fins No Prop			16.5	455	-187.5	-570	9					
			1.12	"			8.5									
			1.13	"			12.0									
			1.14	"			16.5						✓			Very Heavy Coating Kerosene/Talc
			–	ditto →	0		0	1630	150	-26.0			✓			
2.13	72			Support Body + single Semispan 16-006 Fin (Rt side)	0		16.5	158.0	159.5	-36.0			✓			These results N.G.
→				"	+1		→	161.0	163.0	-34.0						Drag Balance wanders
				"	+3		→	156.0	172.5	-25.0						all over the Place
–				"	0		0	82.0	49	-17						Zeroes don't repeat

A9

	TEST CONDITIONS			CONFIGURATION			PERFORMANCE DATA						FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T_∞ [°F]	P_∞ [psf]	RUN #	MODEL CONFIGURATION	α	δ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	pressure [ ]	Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5-6-72	72		1	Support body + 2-0009 Fins	0	$\Delta=0$ $\delta=0$	0	7.7	144.7	45.6	\		—	—			$\Delta=$ T.E. Deflect. in [id]ᵗᵉ $\delta = \frac{\Delta}{400} \times 57.3°$
	72		2.14	''	0	$\Delta=0$ $\delta=0$	16.5	62.0	150.5	38.5				—			
	''		1	ZERO ''	0	$\Delta=0$ $\delta=0$	0	10.0	144.5	45.5	\						
	''		2.15	Body + 2-0009 Fins	0	$\Delta=0$ $\delta=0$	16.5	64.0	150.5	38.5	\						Repeat of 2.14
				Repeat of ZERO	0	$\Delta=0$ $\delta=0$	0	13.5	144.2	45.5							NOTICE of D.. measurement returns.. .. ..
	54		2.16	Body + 2-0009 Fins	0	$\Delta=175$ $\delta=+25°$	0	50.1	144.4	46.2							
			2.16	''	0	$\Delta=175$ $\delta=+25$	16.5	69.0	153.0	38.5							
				''	0	$\Delta=175$ $\delta=+25$	0	11.0	144.2	45.5							Repeat of ....

TEST CONDITIONS				CONFIGURATION	PERFORMANCE DATA							FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T_∞ [F]	P_∞ [psf]	RUN #	MODEL CONFIGURATION	α	δ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5-6-79	75°		2.17	Support Sting + 2-0009 Fins	0	Δ=40 δ=5.7°	0	10.5	144.3	46.0	—		—			Zeros
			"	"	0	Δ=40 δ=5.7°	16.5	6.0	153.5	39.0	—					
			"	"	0	"	0	10.7	144.7	46.0	/					repeat of Zeros
			2.18		0	"	16.5	67.5	153.5	40.0	—	Both Fins	✓			Pronounced separation Line on δ=5.7° @ approx 75%C
	76°		2.19		0	Δ=30 δ=4.3°	0	10.0	144.2	46.0	—					Zeros
			2.19		0	Δ=30 δ=4.3°	16.5	66.0	147.5	38.6	—		—			
			2.19		0		0	11.0	144.3	46.0						repeat of Zeros

A11

TEST CONDITIONS				CONFIGURATION	PERFORMANCE DATA							FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T_∞ [F]	P_∞ [psf]	RUN #	MODEL CONFIGURATION	α	ϕ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/6/79	76°		4.01	Total Hull "Powered Model" Prop-Yellow 5" 3-BLADE	—	—	0	-8.5	-216	-479	1		✓			ZERO
							16.0	500	-200	-483				14550	0	
							16.0	473	-199	-482				16550	.1	
							16.0	450	-199	-482				17400	.2	
							16.0	422	-199	-483				18300	.3	
							16.0	391	-197	-484				19150	.4	
							16.0	379	-197	-463				19650	.5	
	79°						0	-7.5	-216	-435						REPEAT ZERO

A12

TEST CONDITIONS				CONFIGURATION			PERFORMANCE DATA					FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T_∞ [F]	P_∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/1/79	79°		4.02	Powered Motor Yellow 5" 3 Blade	—	—	0	-7.5	-216	-4785	—		1	0	0	ZERO
							0	-16.0	-216	-478				3000	.2	
							0	-36.0	-216	-478				5550	.3	
							0	-78.0	-216	-478				5300	.4	
							0	-107	-216	-478					.5	
	78°		4.03	Powered Mot. Prop-V₂ on 5" 5 Blade			0	-7.5	-216	-453				0	0	repeat zero / Also zero for test 4.03 / cont. of run 4.01 for... covered Sr
							16.0	3755	-199	-454	—			18550	.5	
							16.0	358	-199	-453					.6	
							16.0	344	-199	-451					.7	

A13

	TEST CONDITIONS			CONFIGURATION	PERFORMANCE DATA						FLOW VISUALIZATION	MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T∞ [F]	P∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet # / AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/6/xx	81°		4.03	Powered Model Prop — Yellow 5" 3-Blade			16.0	322	-199	-481	—	—	21000	.8	
							16.0	307	-197	-481	—	—	20000	.9	
							16.0	292	-197	-479	—	—	21050	1.0	REPEAT ZEROS
							0	-6.5	-216	-478	—	—	0	0	
	78°		4.04	Powered Model Prop — Gray 4½ 20 inds (4.5 ...)			0	-9.0	-216	-479	—	—	0	0	ZEROS
							0	-12.0	-216	-479			1240	.2	
							0	-33.0	-216	-479				.3	
							0	-48.5	-216	-479			1300	.4	vibration
							0	-49.0	-216	-479			1343	.5	

A14

Data sheet (rotated landscape table)

DATE	T∞ [F]	P∞ [psf]	RUN #	MODEL CONFIGURATION	α	ρ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/6/79	78°		4.04	Powered Model Prop-Gray 4.5 2"pitch 2 Blades		0	0	-51.5	-216	-474	—		—	?220.6	.6	Vibration
			4.04			0	0	-7.0	-216	-474	—		—	0	0	REPEAT ALSO ZERO for 4.05
5/?/79	78°		4.05			16.0	0	-188	-479	—		—	1200	.05	Blade stalls below 0.1amps
5/6/79	78°		4.06	Powered Model Prop-Black 5" 3-Blades		0	0	12.0	-215	-426	—		1	0	0	ZERO
						0	0	5.0	-215	-496				~2430	.2	
						0	0	-250	-215	-495					.3	
						0	0	-546	-215	-496					.4	
						0	0	-595	525						.5	
						0	0	-1010	512					6550.8	.6	

A15

TEST CONDITIONS				CONFIGURATION				PERFORMANCE DATA					FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T∞ [°F]	P∞ [psf]	RUN #	MODEL CONFIGURATION	α	θ	φ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/__/78	78		4.06	Powered Model Prop-Blade 5" 3-Blade				0	-112	-215	-496	—		—	13000	6	Continued ...
								0	-135	-215	-496	—		—	11030	6	
								0	-175	-215	-495	—		—	12150	7	
								0	-211	-215	-495	—		—	13000	8	
								0	-250	-215	-496	—		—	14240	9	
								0	-263	-215	-475	—		—	16000	10	
	73		4.07	Powered Model Prop-Black 5" 3-Blade				160	150	-215	-476	—		—	0	0	Zero'd also repeats to 0.06
								160	450 -200	-500						0		
								160	450	200 -500 full						13380		

A16

TEST CONDITIONS			CONFIGURATION					PERFORMANCE DATA					FLOW VISUALIZATION	MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T_∞ [°F]	p_∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	ρ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/6/79	78°	4.07		Powered Model Prop - Blades 5" 3-Blades				16.0	444 -177	-500		1		1	15000	.2	
								16.0	425 -171	-499		1		1	17000	.3	
								16.0	406 -199	-500		1		1	20150	.4	
								16.0	387 -177	-499		1		1	20500	.5	
								16.0	372 -200	-477		1		1	21600	.6	
								16.0	359 -230	-500		1		1	21300	.7	
								16.0	344 -201	-500		1		1	21000	.8	
								16.0	327 -204			1		✓	21000	.9	

TEST CONDITIONS			CONFIGURATION				PERFORMANCE DATA					FLOW VISUALIZATION	MOTOR PERFORMANCE			MISCELLANEOUS
DATE	T∞ [F]	P∞ [psf]	RUN #	MODEL CONFIGURATION	a	b	q [psf]	Drag [ ]	Life [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/1/79		2.08		PWD MODEL OCTURA 2.8PP P&P 2 BLADE	0		0	(-)36.5	(-)217	(-)468			1	0	0	Questionable? Zero maybe -27 Drag
								36.5	217	468				1620	0.2	
								40.0	217	468				7020	0.3	
								50.0	217	468				9130	0.4	
								51.5	217	468				9360	0.5	
								52.5	217	468				9640	0.6	
								53.5	217	468				9870	0.7	
								55.0	217	468				10000	0.8	

A18

TEST CONDITIONS			CONFIGURATION		PERFORMANCE DATA								FLOW VISUALIZATION	MOTOR PERFORMANCE			MISCELLANEOUS
DATE	T_∞ [°F]	P_∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	θ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/9/74	-10°		4.09	PWD. MODEL OCTURA 2.8 2 Blade Q	0	0	0	0	-23	-216	-465	—		1	0	0	ZEROS
								16.0	375	-204.5	-470	—		1	4700	.1	
								16.0	352	-205	-444				7700	.1	
								16.0	343	-205	-471				7240	.2	
								16.0	346	-205	-470				7900	.3	
								16.0	340	-205	-467				9720	.4	
5/7/74	75°		4.10	PWD. MODEL OCTURA 2.8 2 BLADE				0	-27	-217	-468				3950	.2	REPEAT OF run 4.08
									-47	-217	-468				5950	.4	
									-48	-217	-468				7900	.5	

5/7/74 75°   0   -23 -216 -468

REPEAT ZERO for run 4.09 4.10

A19

TEST CONDITIONS			CONFIGURATION		PERFORMANCE DATA						FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T_∞ [F]	P_∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/7/79	70		4.11	Powered Model Prop-Yellow 5" 3-BLADE			0	-36	-217	-466	1		1	0	0	ZERO
							0	-44	-217	-466				4000	.2	Repeat of run 4.02
							0	-102	-217	-468				8300	.412	
							0	-101	-217	-467				8100	.4	
							0	-58	-217	-466				0	0	REPEAT ZERO for run 4.11
5/7/79	69		4.12	Powered Model Prop-Yellow 5" 3-BLADE			16.0	471	-205	-463				13000	0	repeat of run 4.01
							16.0	414	-205	-425				17000	.2	
							16.0	373	-205	-462				18600	.4	
							16.0	314	-205	-464				18800	.6	

TEST CONDITIONS			CONFIGURATION				PERFORMANCE DATA					FLOW VISUALIZATION	MOTOR PERFORMANCE			MISCELLANEOUS
DATE	T_∞ [F]	P_∞ [psf]	RUN #	MODEL CONFIGURATION	α	ϕ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/7/79	72°		4.13	Powered Model Prop-Yr/lows 3-BLADE			8	-38	-218	-466	—		1	0	0	Repeat zero data for 4.12 and 4.11 velocs ≒1
														0	0	STALLED
							8	187	-010	-475				750	1.	
							8	183	-112	-475				920	0.05	
							9	180	-112	-594				1040	0.05	
							8	183	-210	-475				1546	0.09	
							8	186	-210	-475				1500	0.1	
							8	192	-210	-465				1840	0.1	
							8	199	-211	-465				2240	0.1	

TEST CONDITIONS				CONFIGURATION	PERFORMANCE DATA							FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T∞ [F]	P∞ [psf]	RUN #	MODEL CONFIGURATION	a	θ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/4/79	75°		4.13	Powered Model Prop-Yellow 5" 3-BLADE			8	203	-212	-465	—		—	1520	.098	
							8	210	-212	-465	—		—	3540	.09	
			4.13				0	0 -34	-217	-466			—	0	0	REPEAT ZERO

A22

TEST CONDITIONS			CONFIGURATION		PERFORMANCE DATA						FLOW VISUALIZATION		MOTOR PERFORMANCE			MISCELLANEOUS
DATE	T_∞ [F]	P_∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	V_∞/V_s	COMMENTS
5/13	75°		4.14	Powered Models reversed in tunnel. Prop — Yellow 5' 5-BLADE			0	555/-223		Disconnect to			✓				Bearing ANR required / constant in order to remain during test. Switch
							8	358 / -220						9220	.055	38.1	Moment scale is disconnected
							8	365 ±5 / -220						9820	.1	45.4	
							8	345 ±5 / -220						9800	.2	50	
							8	368 ±5 / -220						10080	.27	55	This is the last point before the prop-an changes dynastic.
							8	355 ±5 / -220						11600	.07	54	
							8	337 ±5 / -220						12900	.15	61	
							8	325 ±3 / -220						13500	.2	70	
							8	309 ±2 / -220						14430	.3	72.5	

A23

Data sheet (rotated). Handwritten test log.

TEST CONDITIONS				CONFIGURATION				PERFORMANCE DATA						FLOW VISUALIZATION		MOTOR PERFORMANCE			MISCELLANEOUS
DATE	T_∞ [F]	P_∞ [psf]	RUN #	MODEL CONFIGURATION	α	ρ	δ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	Volts	COMMENTS
5/13	77°		4.14	Power Model; reversed in tunnel / Prop - 1/6 //ou 5" 3-Blade	0			8	278 ±3	-220					15300	.4	79	
								8	260 ±2	-220					16050	.5	85	
									157 ±2	-220					19600	1.0	114	
	77°		4.15	Power Model; reversed in tunnel / Prop - 1/5 Nou 5" 3-BLADE	0			0	53	-223					0	0	0	ZEROS
						16.5			609 ±1	-215					16300	0	72	
						16.5			588 ±5	-215					17400	.1	80.5	
						16.5			563 ±5	-215					18250	.2	86	
						16.5			531 ±1	-215					19150	.3	93	
						16.5			513 ±1	-215					19700	.4	98	

A24

Test data sheet (sheet rotated on page).

DATE	T∞ [F]	p∞ [psf]	q∞ [psf]	RUN #	MODEL CONFIGURATION	α	δ	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	Vol [ ]	COMMENTS
5/13	77°			4.15	Power Model reverse in Tunnel / Prop - Yellow 5" 3-BLADE	0			16.5	494	-215					20800 .5	103		MOMENT SCALE DISCONNECTED
5/13	77°					0			16.5	483 ±1	-215					20950 .6	107.5		
5/13	76°			4.16	Power Model / Prop - Yellow 5" 3-BLADE	0			0	32	-217	-501	—		—	0 0	0		ZEROS
									16.5	554	-198	501				9400 0	425		
									16.5	554	-198	-501				9720 .1	45.9		
									16.5	554	-198	-501				9700 .2	48.8		
									16.5	545 ±5				windmilling ↑		10000 .22	51		Currently reverses sharply cannot be made t without reducing tunnel q
									16.5	545 ±5	-198	-501				14800 0	64		
									16.5	530	-198	-503				15600 .1	73		

A25

DATE	T∞ [F]	p∞ [psf]	RUN #	MODEL CONFIGURATION	α	b	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	Vo/ts	COMMENTS
5/13	78°		4.16	Powered Model / Prop-Yellow 5" 3-blade	○		14.5	502	-148	-502	—		—	17000	.2	82	
	76°		4.17	Powered Model / Prop-Yellow 5" 3-blade with honeycomb installed	0		0	43.5	-214	-501	—		✓	0	0	0	
							8	328	-209	-501				2300	.1	13.1	
							8	338 ±3	-209	-502				3840	.1	19.6	
							8	350 ±5	-209	-501				6150	.105	30.2	
							8	345 ±5	-209	-501				9600	.2	48	
							8	343 ±5	-209	-502				9690	.27	51	
							8	339 ±5	-209	-501				9750	.3	52	
							8	345 ±2	-209	-502				9970	.4	55	Current

A26

DATE	T∞ [°F]	P∞ [psf]	RUN #	MODEL CONFIGURATION	a	b	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/13	76°		4.17	Powered Model with Tail housy comb installed Prop -1/16 Yaw 5" 3-Blade	0		9	318	-209	-505				11580 .25	60	I drop can be delayed to 0.5 a by carefully increasing volts — Bottom hysteresis
							8	303	-209	-505				12450 .3	64	
							8	282	-209	-505				13570 .4	71	
							8	258	-209	-505				14470 .5	78	
5/13	78°		4.18	Power Model with Tail housy comb installed Prop - Yellow 5" 3-Blade	0		16.5	644	-198	-510				9220 0	41	
							16.5	650	-199	-511				9750 .1	46.3	
							16.5	646	-199	-510				9960 .2	49.3	
							16.5	646	-200	-509				10120 .25	52	Correct drop at A .27
							16.5	642	-199	-512				12450 0	56	After current dies

DATE	T_e [F]	p_∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/13	80°		4.1B	Powered Model 1 with Tail assy comb installed Prop-Yellow 5" 3-BLADE	0		16.5	617	-199	-509	1		1	14330	.1 / 67	
							16.5	593	-199	-512				15620	.2 / 75	
							16.5	573	-199	-509				16740	.3 / 83	
							16.5	543	-199	-508				17500	.4 / 89	
							16.5	525	-199	-511				18230	.5 / 94	
							16.5	534	-199	405				21000	1.0 / 123	
						0	33	-216	-493				0	0 / 0	REPEAT 0° 4.01 and 4.03
5/13	80°		4.19	Power Model 1 Prop-Yellow 5" 3-BLADE			16.5	552	-195	-494				9400	0 / 4119	
							16.5	544	-194	-494				9750	0.1 / 458	

A28

DATE	T∞ [F]	P∞ [psf]	RUN #	MODEL CONFIGURATION	α	δ	q [psf] b	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	Vo/Vs	COMMENTS
5/13	79°		4.19	Power Model Prop-Yellows" 3-BLADE	0		14.5	565	-195	-496				9960	.15	4.76	repeat of run 4.01 and 4.03
							16.5	555	-195	-495				13780	0	65	Current drop at .18 to negative value
							16.5	533	-195	-492				15800	0.1	73	
							16.5	605	-561	-494				17120	0.2	82	
							16.5	884	-565	-494				18050	0.3	88	
							16.5	594	-195	-497				18600	0.4	93	
							16.5	438	-195	-498				19120	0.5	99	
							16.5	325	-195	-497				21750	1.0	127	
5/13	82°				0		0	34	-217	-493				0	0	0	repeat zero

A29

TEST CONDITIONS			CONFIGURATION		PERFORMANCE DATA							FLOW VISUALIZATION		MOTOR PERFORMANCE			MISCELLANEOUS
DATE	T_∞ [F]	P_∞ [psf]	RUN #	MODEL CONFIGURATION	α	ρ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	V/l½	COMMENTS
3/4	72°		4:20	Power Manual Prop – Yellow 5" Trimmed to 3.6" 3-BLADE	0		0	36	-215	-496	1		✓	0	0	0	ZEROS
						8	237 ±3	-205	-498				1920 .125		11.5		
						8	252	-205	-498				4530 .15		24		
						8	257	-205	-498				8050 .15		40.3		
						8	255	-205	-498				9330 .2		41		
						8	253	-205	-498				9910 .3		52		
						8	251	-205	-490				9970 .35		54		
						8	242	-205	-498				10920 .25		55		Current .8
						8	218	-205	-496				13270 .3		67		

TEST CONDITIONS			CONFIGURATION		PERFORMANCE DATA							FLOW VISUALIZATION		PERFORMANCE (MOTOR)			MISCELLANEOUS
DATE	T_∞ [°R]	p_∞ [psf]	RUN #	MODEL CONFIGURATION	a	θ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	Vel/s	COMMENTS
5/1	73°		4.20	Power Model / Prop. — Yellow 5"3-Blade TRIMMED TO 3.6"	0		8	195	-205	-498				15300	.4 79		
							8	163	-205	-498				17000	.5 90		
							8	128	-205	-413				19500	.7 107		
5/1	74°		4.21	Power Model / Pr-p. — Yellow 5"4-Blade TRimmed To 3.6	0		0	37	-216	-496				0	0 0		
							16.5	432	-195	-499				1520	.05 78		
							11.5	438	-194	-501				5750	.1 19		
							16.5	468	-195	-500				8420	.09 40		
							16.5	946	-191	-505				9690	.2 49.2		
							16.5	472	-195	-498				11730	.11 55		Conical flow 2

A.31

TEST CONDITIONS				CONFIGURATION			PERFORMANCE DATA					FLOW VISUALIZATION		MOTOR PERFORMANCE			MISCELLANEOUS
DATE	T∞ [F]	P∞ [psf]	RUN #	MODEL CONFIGURATION	a	θ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	Vo/ts	COMMENTS
5/11	74°	4.21		Power Model Prop - Yellow 5" 3-blade		16.5	443	-195	-499					15280	.2	74	
						16.5	417	-194	-498					17120	.3	85	
						14.5	372	-195	-498	—				19750	.5	10?	
5/14	72°		1.06	Power Model with Prop - Yellow 5° 3-blade TRIMMED D TO 3.6" TESTED Hondycomb inlet		0	37	-216	-496	-500			✓	0	0	0	
						8	185	-209	-500					960	.1	6.4	
						8	190	-208	-500					3240	.15	18	
						8	200	-208	-500					5740	.14	295	current draw 1.7
						8	195	-208	-500					58860	.2	447	
						8	165	-2065	-??					9600	.3	52	

	TEST CONDITIONS			CONFIGURATION			PERFORMANCE DATA					FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T_∞ [F]	P_0 [psf]	RUN #	MODEL CONFIGURATION	α	δ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/14							8	187	-5885	-500				9900 .4	55	Current that ...
							8	175	-2085	-500				10930 .28	57	.4
							8	138	-2085.5	-500				14440 .7	75	
							8	110	-2085	-500				16400 .5	86	
							8	63	-2085.5	-500	Total hull			18200 .7	104	
5/14		1.07	honeycomb in Tunnel inlet, no PROP		0		8			—			✓			ZERO
5/14		1.08	Total hull		0		0	37	-214	-497	—					
							8	161	-207	-502						
							14.1	244	-198	-502						

TEST CONDITIONS			CONFIGURATION				PERFORMANCE DATA					FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T_0 [F]	P_∞ [psf]	RUN #	MODEL CONFIGURATION	α	δ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/14	75°		1.07	TOTAL HULL	0		14.7					TOTAL hull	✓			
5/14	75°		1.10	TOTAL HULL	0		14.1					" "	✓			
5/14	75°		1.11	TOTAL HULL	0		14.1					TOTAL Hull wet coating in to show separation	✓			
5/14	75°		1.12	TOTAL HULL	0		14.1					TOTAL HULL spot TRIP at .25 position on body	✓			

A34

TEST CONDITIONS				CONFIGURATION				PERFORMANCE DATA				FLOW VISUALIZATION		MOTOR PERFORMANCE			MISCEL
DATE	T_∞ [F]	P_∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	Vol/rs	COMMENTS
5/20		4.22		Powr Model No Prop - No Load			0							600	.17	6.5	
														1380	.2	10.83	
														3870	.25	23.2	Beginning of shaft vibration
														5120	.265	28.6	Shaft vibration smooths out
														5540	.245	30.5	
														6970	.245	36.8	
														8960	.25	51.0	
														10380	.3	53.9	Beginning of shaft vibration
				4										10500	.35	55.7	

	TEST CONDITIONS				CONFIGURATION	PERFORMANCE DATA							FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	θ_∞ [F]	p_∞ [psf]	U_∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/20				4.22	Power Model No Prop - No Load			0				—		—	13370 .30	63.1	Vibrator smooths out
															13980 .245	69.1	
															17050 .25	83.5	
															19140 .255	93.5	
															21550 .265	104.4	
															25950 .265	116	
														✓			Honeycomb at Inlet (3 sheets)
5/20	67°		1.15		Hull with .008 Fins No Prop	0	32	-219	-494	10							
						13.5	219	-208	-497								
	72°					0	32	-219	-494								repeat of above

	TEST CONDITIONS			CONFIGURATION					PERFORMANCE DATA					FLOW VISUALIZATION		MOTOR PERFORMANCE			MISCELLANEOUS
DATE	T_∞ [R]	p	q_∞ [psf]	RUN #	MODEL CONFIGURATION	a	b	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	Volts/Amps	COMMENTS
5/20	72°			1.16	Total Hull with 0009 Fins, No prop.		0	33	-219	-444	10			✓				
							13.5	224	-209	-496								
				1.17	Total Hull with 0009 Fins, Abprop.		13.5	218	-209	-496	10			✓				
							0	37	-219	-444								yeffet zero
	73°			5.01	5"3Blade YellowProp Full Body		0	33	-220	-449	11			✓				Rake 3.5"Aft 1.1"off cntr
							13.5	334	-210	-449					5100	.07	24.3	
								361	-210	-500s					9300	.1	93.4	
								316	-210	-449					13990	.2	69.8	
								285	-210	-444					14860	.3	73.8	

DATE	Tₐ [°F]	RUN #	MODEL CONFIGURATION	α	ρ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	Volt/It	COMMENTS
5/10	76°	5.01	Powered Model Prop-5" 3-blade Yellow			13.5	263	-210	-499	11		✓	15800	.4	80.1	
							234	-210	-500				16630	.5	86.7	
							209	-210	-500				17570	.6	93.5	
							184	-210	-499				18050	.7	95.0	
							162	-210	-500				18630	.8	97.6	
							140	-210	-500				19260	.9	100	
							128	-210	-501				19630	1.0	109	
		5.02	Powered Model Prop-5" 3-blades Yellow			13.5				12		✓				
		5.03	Full Body Honeycomb Ring out tail No prop			13.5	310	-215	-478	12A		✓				ZEROs for run 5.03

O   33   -221   -493

TEST CONDITIONS				CONFIGURATION					PERFORMANCE DATA					FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	θ° [°]	p∞ [psf]	RUN #	MODEL CONFIGURATION	α	δ	θ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/20	79°		5.04	Same as 5.03 Rake moved 1.1" off cntr				13.5	467	-210	-497	12A					Rake 3" Aft 1.1" off cntr
			5.05	5" 3Bladed Full Body with Honeycomb Faring (tail)							-497	12A			9070	.1 42.5	
								357		-211	-497				13200	.25 65.0	
								318		-210	-497				14740	.4 76.0	
								301		-210	-497				15830	.5 82.0	
								267		-210	-497				16400	.6 86.8	
								254		-210	-497				17040	.7 88.0	
								232		-210	-497				17840	.8 92.0	
								193		-210	-497				18920	1.0 92.0	

0 3G -222 -493

ZEROS for 5.05

TEST CONDITIONS			CONFIGURATION		PERFORMANCE DATA							FLOW VISUALIZATION		MOTOR PERFORMANCE			MISCELLANEOUS
DATE	T_∞ [F]	p_∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	Voltage	COMMENTS
5/20			5.06	Same as 5.05 Rake "Central"			13.5				13						
5/21			1.18	Total Hull no prop waterlines back 3.6" up 2.2"			13.5				14						
↓			1.19	" " Except 3.3" off cntr			13.5				14						
			1.20	Total Hull Rake aligned with Fins			13.5				15						
			1.21	Same as 1.20 but nose trip @2.8"			13.5				15						
			4.23	Powered Model Nose trip @2.8"			0	33	-220	-494	—						
			↓				13.5	317	-207	-499				1500 1		885	
							13.5	330	-207	-494				9350 15		454	
			↓				13.5	317	-207	-494				12000 2		609	

A40

TEST CONDITIONS			CONFIGURATION				PERFORMANCE DATA					FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T∞ [F]	p∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/21			4.23	Powered Models WITH Nose Trip Prop-Yellow 5" 3-Blade			13.5	310	-207	-498				14290	.3 71.5	
							13.5	287	-207	-498				15250	.4 78.3	
							13.5	258	-207	-499				16200	.5 85.0	
							13.5	228	-207	-499				17110	.6 92.0	
							13.5	202	-207	-498				17800	.7 96	
							13.5	182	-207	-498				18620	.8 91	
							13.5	147	-207	-498				19890	1.0 103	
					0	0	0	547	-020	-547						
			4.24	...1, Propelled Body	0	13.5						Afterbody & Tail Fins	✓			Prop HW = 15.00

TEST CONDITIONS				CONFIGURATION				PERFORMANCE DATA						FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T∞ [F]	P∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	p	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5·21			3.01 4.25	Hull without Prop" Nose trip @ 2.8	0		Ⓓ	29	-200	-494							
					2°	1	13.5	250	-206	-497							
					3.6°		13.5	254	-203	-494							
					-2°		13.5	254	-203	-493							
					-4°		13.5	255	-210	-506							
							13.5	256	-214	-511							VEC SAT ZERO
			3.02 486	Hull without prop NO TRIP	0		Ⓓ	34	-220	-496							
					2°		13.5	228	-207	-500							
				1'	2°		13.5	228	-203	-495							

A42

TEST CONDITIONS				CONFIGURATION		PERFORMANCE DATA							FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T_o [F]	P_∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
5/21			2.02 4.26	Hull without Prop No TRIP	3.3°		13.5	230	-20)	-492						
					-2°		13.5	230	-210	-505						
					-4°		13.5	231	-214	-510						
5/21			2.03 4.27	Basic Hull NO HORIZ FINS	0		13.5	211	-200	-500			✓			
					2°		13.5	212	-199	-470						
					3.9°		13.5	212	-199	-481						
					-2		13.5	210	-201	-509						
					-4°		13.5	210	-202	-518						
					0		0	22	-2145	-493						ZERO flow rdg 4.29

A43

TEST CONDITIONS				CONFIGURATION				PERFORMANCE DATA				FLOW VISUALIZATION		MOTOR PERFORMANCE			
DATE	T_∞ [F]	P_∞ [psf]	RUN #	MODEL CONFIGURATION	α	θ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	Vehicle	COMMENTS
	72°		5.07	Full Vehicle 5"Dx3"P Yellow 3BLD No Hub		0	0						✓				
				"		13.5	13.5				16						
			5.08	"		0	0										
						13.2 / 13.5	310	-215	-488					14,100	0.2	68.0	
							552	-215	-438					16,440	0.4	71.0	
							206	-214	-438					17,100	0.6	74.0	
							551	-214	-489					1,100	0.8		
							105	-214	-424					20,300		111	
						0	29.5	-218	-496								

Data Sheet — Handwritten Test Log

DATE	T∞ [F]	P∞ [psf]	RUN #	MODEL CONFIGURATION	α	θ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	Vc [/s]	COMMENTS
6/1	75		5.01	Full Vehicle 5'Dx13"P-Chip #ft 3610 NO HUB			13.4 / 13.5	290	215	440				12,000 / 0.2	58.1		
			5.10	"				228	515	484	17			16,140 / 0.4	84.5		
								281	515	488				11,500 /	101		
								126	215	488				22,450 / 0.9	125		
			5.11	Full Vehicle 5"Dx4"P Yellow 3810 NO HUB	0			08	215	488				24,440 / 1.0	139		21-120
					13.4 / 13.5			27.5	218	496				16,380 / —	50.4		
					11			220	215	480				10,330 / 0.2	74.1		
								242	515	484				13,200 / 0.4			
								44	515	484				14,140 / 0.6	91.5		

A45

DATE	T∞ [F]	p∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Life [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	V/t/?	COMMENTS
1/(?)			5.11	Full Vehicle 5"Dx4"P 4Bladed no HUB			13.4 / 13.5	150	-315	-466				15,600	6.8	10.3	
				"			11	112	-315	-468				16,670	1.0	101	
				"			55	-515	-498					17,600	1.2	111	
			5.12	"			13.5				17.8		✓				
			5.13	Full Vehicle 5"Dx4"P Clipped Tips no HUB			0 / 13.2	080	714-716	1176	27.8						
							12.4	-515-214		1214				16,320	43.1		
								177	-515-	1451				16,560	5.5		
														14,300	1		
								105	-515-	1413				10,300	161		

TEST CONDITIONS			CONFIGURATION			PERFORMANCE DATA						FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS	
T∞ [F]	P∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	V [ ]	COMMENTS
88°		5.?	cnt		13.3 13.4	80	215	-215	-490				21,700	1.0	124	
	5.4	514	Full vehicle. — 5"∅x3"p 2 bladed — no hub		0	37	215	-219	-494	19 13		✓	0	0		This is a 2 bladed prop
					13.3	215	215	-215	-488	-488			16,080	0.2		
						265	215	-215	-489				10,450	0.14		
						208	215	-215	-488				5,200	18		
						120	215	-215	-488				17,750	95		
						120	215	-215	-488				18,	111		
						75	215	-215	-488				19,			

TEST CONDITIONS			CONFIGURATION		PERFORMANCE DATA							FLOW VISUALIZATION		MOTOR PERFORMANCE			MISCELLANEOUS
DATE	T_g^o [°F]	p_s [psf]	RUN #	MODEL CONFIGURATION	α	ϕ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	V [ ]	COMMENTS
1/16	71		5.15	Full Vehicle Octave 2.8 No HUB		0	35	-219	-497		20/14				9660	0.2	41.6	Z v
						13.5	258	-213	-492						16130	0.1	83.5	
						1	214	-213	-490						21,630.6		104	
							193	-213	-490						24,440.8		155	
						13.5	128	-213	-490		20/14							
				5.16	Full Vehicle Octave 2.8 with Hub		0	29	-220	-492									
						13.5	244	-213	-494						9250	0.2	45.1	
							215	-213	-490						17100	0.4	85.8	

DATE	T_∞ [F]	P_∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	W/S?	COMMENTS
7/1	0%		5.17	Octava 2.8 with Hub		13.5	185	-213	-455				20630 0.6	110.8		
			↓	→		13.5	175	-213	-453				22200 0.8	123		
			5.18	↓		13.5				21/5						

(TEST CONDITIONS | CONFIGURATION | PERFORMANCE DATA | FLOW VISUALIZATION | MOTOR PERFORMANCE | MISCELLANEOUS)

Test data sheet (rotated). Column groups: TEST CONDITIONS | CONFIGURATION | PERFORMANCE DATA | FLOW VISUALIZATION | MOTOR PERFORMANCE | SCHLIEREN

DATE	T°o [F]	P∞ [psf]	RUN #	MODEL CONFIGURATION	α	δ	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
7/18/9	70°	2.20		Support Body + 2~16-006 Fins	0	0	0	0	32.0 34.0+4.0	40.0	38.5	1					
					0	0	0	13.5	40	50	34.0						
					+1	0°			70	57	37						
					+2	0°			72	58	39						
					+3	0°			77	62	42						
					+4	0°			83	87	44						
					+5	0°			97	72	47						
					+6	0°			72	74	31						
					+7	0°			77	86	28						

Comment (one row): ~ C_Lα ~ 0.09 / degree

A50

Test data sheet (handwritten). Section headers across the top: **TEST CONDITIONS | CONFIGURATION | PERFORMANCE DATA | FLOW VISUALIZATION | MOTOR PERFORMANCE | MISCELLANEOUS**

DATE	T2 [°F]	Pa [psf]	RUN #	MODEL CONFIGURATION	α	θ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
6/9	70°		2.20	Support Body + 2-16-00G Fins	-3	30 19.5	85	52	35	25						
			↓	-4	6		87		31	23						
	74°			-5	6		93		29	22						
			↓	0	6		72	51	51	35						
			2.20	"	0	0	0	37	44	37						Zeroes
			2.21	"	R +9.26° / L +8.50°	13.5	72	55	55	36.5						
			2.122	"	R +9.26° / L +8.50° D	13.5	71	54	54	34						Repeat of 2.21
			2.22	"	0	"	0	36.5	44	34						Zeroes
			2.23	"	R / 6	+3.5										

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DATE	T∞ [F]	p [psf]	RUN #	MODEL CONFIGURATION	α	δ	b	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	V&ITS	COMMENTS
6/8	75		2.23	Suspend Body + 2-16-00c Fins	R-12.7° 0 LO	-12.7° O	0	0	31	45	37.5							Left crank could Not be held by Set screw
			↓	"	0	"	13.5	72	47	34								
			2.24	"	O	0	0	31	44	38								Repeat 2.2c at α = δ = 0
			"	"	0	0	13.5	70.5	15	35								"
			2.25	"	0													
6/9			5.17	Powered Model Octane 2.8	0	0	3.0	-220	-460	22 16							
			"	"			13.5	208	-210	-460 16	22		✓	11,000	0.25	54.8	4-16-00c Fins Installed + Newtail cone
			"	"			13.5	185	-210	-480 16	22			15,000	0.38	74.0	

TEST CONDITIONS			CONFIGURATION				PERFORMANCE DATA					FLOW VISUALIZATION		MOTOR PERFORMANCE		SCINTILLATION
DATE	T_∞ [F]	P_∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
2/50			5.20	Fully Appended NO PROP			0	25.5	-217	-490	22					Manual tel... us...
			''	''	0	6	13.5	215	-208	-480						
			''	''	+2	0	11	215	-204	-482						
			→	→	-2	0	→	215	-212	-493						
					-4	0		217	-215	-497						No speed...
					-6	0		220	-219	-492						

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TEST CONDITIONS				CONFIGURATION		PERFORMANCE DATA							FLOW VISUALIZATION		MOTOR PERFORMANCE			MISCELLANEOUS
DATE	T_0 [F]	p_0 [psf]	p_s [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	V_0/x	COMMENTS
6/14/?				5.21	Full Powered Vehicle Octane 2.8 Prop New tail cone			0	27	-221	-482.5							beams
								13.5	217	-212	-483.5	23/16			11,000	.24	51.6	
								5.31	181	-212	-481	23/16			15,000	.375	71.7	
								13.51	441	-2125	-483	23/16			20,000	.6	49.1	
								13.5	112	-2125	-483	23/16			24,000	.73	112	
				5.22	Powered Vehicle MK 30 Prop New tail cone			0	26	-221	-481	24/17						fins
								13.5	236	-212	-488	24/17			11,000	.185	49.5	
								13.5	238	-212	-486	24/17			15,000	.22	67.3	
								13.5	217	-212	-488	24/17			24,000	.29	105.1	

TEST CONDITIONS			CONFIGURATION		PERFORMANCE DATA						FLOW VISUALIZATION	PERFORMANCE				MISCELLANEOUS
DATE	T_∞ [F]	p_∞ [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	V/V	COMMENTS
7/14/9			5.23	Powered Vehicle Yellow 3-Blade 4"RPM clipped to 3.6 inches			0	27	-222	-485							Zeros
			"	"			13.5	242	-213	-486	25/18			11,000	.185	50.8	
			"	"			13.5	192	-213	-487	25/18			15,000	.49	74.0	
			"	"			13.5	118	-213	.487	25/18			20,000	.8	97	
			5.24	Powered vehicle Yellow 3-Blade 4"RPM NOT CLIPPED			0	23.5	-222	-486							Zeros
							13.5	278	-213	-488	2c/17			11,000	.145	50.7	
							13.5	154	-213	-487	2c/17			15,000	.79	82.6	
							13.5	-12	-213	-188	2c/17			16,900	1.53	127	

TEST CONDITIONS			CONFIGURATION		PERFORMANCE DATA							FLOW VISUALIZATION		MOTOR PERFORMANCE			MISCELLANEOUS
DATE	Ts [F]	Ps [psf]	RUN #	MODEL CONFIGURATION	α	β	ρ	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	Vo/Vs	COMMENTS
3/14/?	0		5.25	Fwd Model Octava 1270 new Hub			0	22	-223	-482							
						13.5	247	-214	-484	27/20			11,000	.14	46.7	
						13.5	222	-214	-483	27/20			15,000	.245	66.6	
						13.5	203	-214	-484	27/20			18,450	.365 (.375)	85.0	I drops with time
						13.5	181	-214	-484	27/20			22,000	.425	101.2	
						13.5	151	-214	-484	27/20			25,000	.55	117	

	TEST CONDITIONS			CONFIGURATION	PERFORMANCE DATA							FLOW VISUALIZATION		MOTOR PERFORMANCE			MISCELLANEOUS
DATE	T_∞ [F]	P_s [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	V [ ]	COMMENTS
7/14/??		5.26		FWD MODEL GREY 2 BLD New Hub			13.5	304 -214	-467	28 ±1			11,000	.12	119		
				→			13.5	297 -214	-488	28 ±1			15,000	.16	16.8		
							13.5	275 -213	884	28 ±1			18,400	.21	85.1		
			▽				13.5	177 -214	-488	28 ±1			2450	.03	118		
						NOT RUN POOR PERFORMANCE								VET 7 1111 ...			
			6.24	FWD MODEL 2-GREY 2 BLD NEW HUB													
			6.27	Full Model NO PROP New Hub		0	0	24	22 -422								
				"			13.5	211 -212	-491								
			1.33	Model's mounts only		0	0	34	112.3	36.5							
			"	"			13.5	127 118	30								

Wind Tunnel Test Data Sheet

	TEST CONDITIONS			CONFIGURATION		PERFORMANCE DATA							FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T_0 [F]	p_s [psf]	RUN #	MODEL CONFIGURATION	α	σ	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	Pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
2/14/9?			131	Mount Only Electric wires Removed				13.5 114		30	29						
→			2.25	Support Body No Fins			0	0									
			11	11	0			13.5 66	53	30.5							
					+1			65.5	53	31							
					+2			65.5 65	53	30.5							
					+3			65.5	52.7	30.5							
					+4			59	52.7	30.5							
					5+			66.5	52.7	31							
					+6			66	52.7	30.5							

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	TEST CONDITIONS			CONFIGURATION		PERFORMANCE DATA						FLOW VISUALIZATION		MOTOR PERFORMANCE		MISCELLANEOUS
DATE	T_0 [F]	P_0 [psf]	RUN #	MODEL CONFIGURATION	α	β	q [psf]	Drag [ ]	Lift [ ]	Moment [ ]	pressure Sheet #	AREA OF FLOW VISUALIZATION	Photo?	RPM	Current [ ]	COMMENTS
9/14/??		2.25		Support Body NO FINS	+7		13.5	66.2	52.7	30.5						
					+1		66.5	52.7	30.0							
					−2		67.0	52.7	30.0							
					−3		67.0	52.3	30.0							
					−4		67.1	52.3	30.0							
					−5		67.0	52.2	30.0							
		1.30		Model Mounts NO ELECT. WIRE No Inlet Honeycomb			0	36	118.5	38						Test Run in Vestibule of tunnel
							16.5	167	130	30.5						

MANOMETER DATA

Rake Location: _____

Comments: _KEROSINE_ S.G. ~ .80 _____

_____

_____

_____

_____

_____

_____

_____

[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: _____

MANOMETER INCLINE: _____90°_____

hieght (in.)

Tube #					
1 2					
3 4					
5 6					
7 8					
9 10					
11 12					
13 14					
15 16					

Location	STATIC	TOTAL	UPPER	LOWER	Right	LEFT
(14,0,0)	4.18	0.25	3.80	3.90	3.85	3.90

MANOMETER DATA

WAKE RAKE

Sheet No. 2

Rake Location: _____

Comments: KEROSINE S.G. = .80

_____
_____
_____
_____
_____
_____
_____
_____
_____

[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: _____

MANOMETER INCLINE: 90°

hieght (in.)

Tube #					
1 2					
3 4					
5 6					
7 8					
9 10					
11 12					
13 14					
15 16					

Location	STATIC	TOTAL	UPPER	LOWER	Right	LEFT
(14,0,0)	4.12	.25	3.70	3.83	3.85	3.89

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MANOMETER DATA

WAKE RAKE

Sheet No. ___3___

Rake Location: _____

Comments: _Kejssivr S.G - .80_

[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: _____

MANOMETER INCLINE: ___90°___

hiejcr ini

Tube #					
1 2					
3 4					
5 6					
7 8					
9 10					
11 12					
13 14					
15 16					

Location	STATIC	TOTAL	UPPER	LOWER	RIGHT	LEFT
(35,0,75)	4.03	.21	3.58	3.78	3.76	3.81

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MANOMETER DATA

<u>WAKE RAKE</u>

Rake Location: _____ None _____

Sheet No. ___4___

Comments: _Kerosine S.G. = .80_

[WAKE RANK LAYOUT]

<u>MISCELLANEOUS PRESSURE READING</u>

MANOMETER INCLINE: _____

MANOMETER INCLINE: ___30°___

hieght (in)

Tube #					
1 2					
3 4					
5 6					
7 8					
9 10					
11 12					
13 14					
15 16					

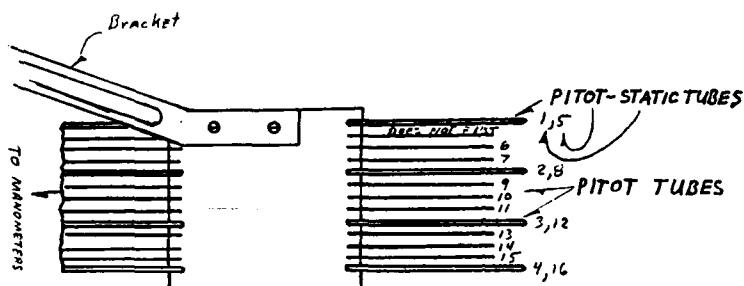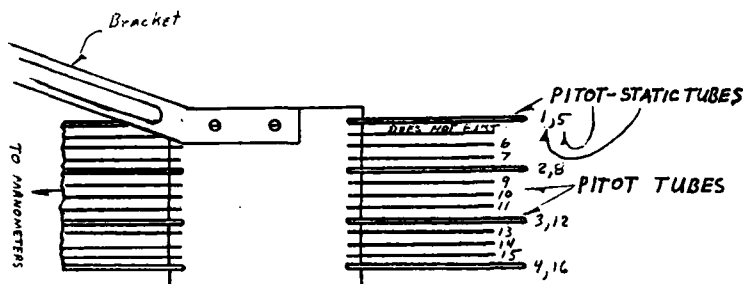| Location	STATIC	TOTAL	UPPER	LOWER	RIGHT	LEFT
(35,0,0) R_i = 14	6.60	0.18	6.00	6.03	6.21	6.18
(35,0,0) R_i = 15	7.13	0.18	6.37	6.53	6.60	6.65
(35,0,0) R_i = 16	7.55	0.20				
(35,0,0) R_i = 17	8.02	0.21				
(35,0,0) R_i = 18	8.29	0.21				

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MANOMETER DATA

WAKE RAKE

Rake Location: _____None_____

Comments: _Kerosine S.G. = 0.80_

[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: _____

MANOMETER INCLINE: ___30°_____

Hieght (in.)

Tube #							Location	STATIC	TOTAL	UPPER	LOWER	RIGHT	LEFT
1 2							(35,0,0)	7.58	0.18	6.87	7.05	7.02	7.07
3 4							(35,0,2.5)	7.63	0.35	6.62	7.32	7.09	7.21
							(35,0,5)	7.60	0.12	6.80	7.10	7.18	7.09
5 6							(35,0,7.5)	7.71	0.42	6.78	7.16	7.15	7.23
7 8							(35,0,10.0)	7.75	0.18	6.90	7.21	7.09	7.31
9 10							(35,0,12.5)	7.75	0.40	6.94	7.18	7.10	7.50
11 12							(35,0,-2.5)	7.80	0.35	6.77	7.31	7.18	7.21
13 14							(35,0,-5.0)	7.70	0.28	6.82	7.20	7.15	7.25
15 16							(35,0,-7.5)	7.68	0.35	6.78	7.30	7.21	7.32
							(35,0,-10.0)	7.57	0.31	6.63	7.29	7.09	7.12
							(35,0,-12.5)	7.57	0.46	6.66	7.01	6.90	7.36

MANOMETER DATA

WAKE RAKE

Rake Location: _____

Comments: _____
_____
_____
_____
_____
_____
_____
_____
_____

[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: _____

MANOMETER INCLINE: ___ 30° ___

Tube #					
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					

Location YAW HEAD (X,Y,Z)	Static 19	Total 20	UP 21	LOW 22	R+ 23	Left 24
Run 1.01 28.5 0, -10	8.15	0.35	7.43	7.60	7.39	7.80
Run 1.02 28.5 0, -10	8.15	0.38	—	—	—	—
Run 1.03 28.5 0, -10	8.19	0.41	—	—	—	—
Run 1.04 28.5 0, -10	8.19	0.39	—	—	—	—
Run 1.05 28.5 0, -10	8.18	0.39	—	—	—	—

A65

MANOMETER DATA

WAKE RAKE

Sheet No. ___7___

Rake Location: _____None_____

Comments: _Total pressure (#20)_
and static pressue (#19)
only measured on series 2
runs, Yaw head located
_at X =+28.5", Y =0", Z = -10"_

Bracket

PITOT-STATIC TUBES
1,5
6
7
2,8
9
10
11
3,12
13
14
15
4,16

does not exist

PITOT TUBES

TO MANOMETERS

[WAKE RANK LAYOUT]

Kerosene S.G. =0.80

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: _____

MANOMETER INCLINE: ___30°___

Yaw Head @ 28.5, 0, -10

Tube #						Location						
1 2						Run	Static #19	Total #20				
3 4						2.01 start	7.83	.34				
						2.01 End	7.85	.33				
5 6						2.02	7.83	.34				
7 8						2.04 start	7.85	.33				
9 10						2.04 end	7.85	.35				
11 12												
13 14												
15 16												

MANOMETER DATA

WAKE RAKE

Sheet No. **8**

Rake Location: **Pitots 0.5" fwd. of aft end of tail boom**
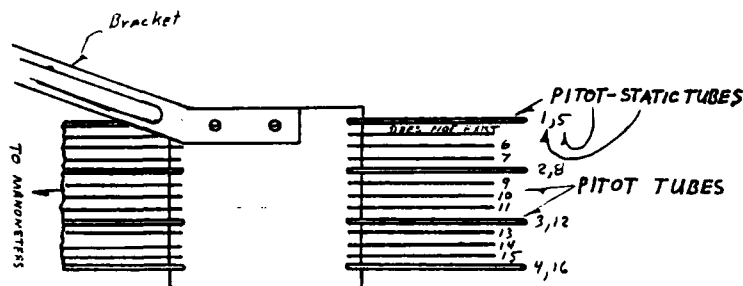
Comments: _____

[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: **30°**

Tube #	Y	Run 1.08	Δh	$\frac{q}{q_0}$	$\frac{U}{U_0}$
1	0.090	4.75			
2		7.00			
3		7.10			
4		7.50			
5	.090	5.27	1.93	0.133	.365
6		5.00	2.20	0.152	0.390
7		4.76	2.44	.168	.410
8		4.75	2.45	.169	.411
9		3.73	3.47	.239	.489
10		2.96	4.24	.292	.541
11		2.35	4.85	.334	.578
12		1.85	5.35	.369	.607
13		1.30	5.90	.407	.638
14		1.00	6.20	.428	.654
15		0.82	6.38	.440	.663
16		0.78	5.42	.443	.665

MANOMETER INCLINE: **30°**

Yaw Head @ 28.5, 0, -10

Location Run	Static 19	Total 20					
2.11, Start	8.41	.98					
2.11, Finish	8.45	1.01					
2.12, START	8.51	1.01					
2.12, Finish	8.41	1.04					

Kerosene S.G. = 0.90

A67

MANOMETER DATA

WAKE RAKE

Rake Location: Pitots aligned with aft end of tail boom

Comments:

Bracket

TO MANOMETERS

TUBES NOT EXIST

PITOT-STATIC TUBES 1,5

6
7
2,8
9
10
11

PITOT TUBES

3,12
13
14
15
4,16
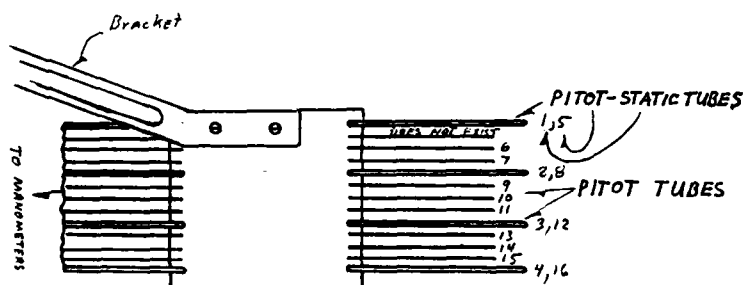
[WAKE RANK LAYOUT]

Pitots at end of tail boom

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: 30°

MANOMETER INCLINE:

Tube #	y	Run # 1.09	1.10	1.11	
1	0.110"	4.47	5.97	7.89	
2		4.68	6.29	8.25	
3		4.55	6.18	8.11	
4		4.61	6.29	8.28	
5	0.110	3.04	4.16	5.50	
6	0.22	2.79	3.76	4.94	
7	0.34	2.44	3.29	4.27	
8	0.47	2.11	2.72	3.47	
9	0.59	1.78	2.11	2.65	
10	0.72	1.40	1.56	1.90	
11	0.84	1.11	1.19	1.39	
12	0.97	0.88	0.90	0.95	
13	1.10	0.80	0.88	0.89	
14	1.22	0.80	0.86	0.90	
15	1.35	0.79	0.82	0.87	
16	1.47	0.78	0.80	0.83	

Location.

MANOMETER DATA

WAKE RAKE   Sheet No. _10_

Rake Location:
1.15 – Pitots 0.5" Fwd of tail boom on 2
1.16 – Pitots 3.5" Aft of tail boom on 2 and #4,16 Centered
1.17 – Pitots 3.5" Aft, #4,#16 – 1.1" off cntr   Comments: _____

[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: ___30°___   MANOMETER INCLINE: _____

RUN NO.

Tube #	y	1.15	1.16	1.17	
1		6.72	6.67	6.80	
2		6.76	6.70	6.85	
3		6.70	6.65	6.83	
4		6.80	6.71	7.05	
5	0.10"	4.09	2.26	2.21	
6		3.79	2.30	2.19	
7		3.55	2.48	2.20	
8		3.28	2.69	2.20	
9		3.07	2.87	2.20	
10		2.87	3.08	2.21	
11		2.64	3.38	2.26	
12		2.46	3.70	2.31	
13		2.31	4.03	2.40	
14		2.27	4.54	2.45	
15		2.22	5.27	2.62	
16		2.19	5.98	2.81	

Location

MANOMETER DATA

WAKE RAKE   Sheet No. __11__

Rake Location: <u>Pitots 3.5" AFt, #4,16 1.1" off center</u> Comments: <u>Run #5.01</u>
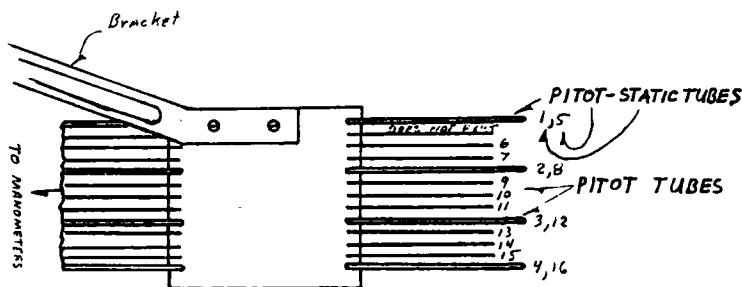
[WAKE RANK LAYOUT]   MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: __30°__   MANOMETER INCLINE: _____

Tube #	4	RPM				Location						
		5,000	11,000	15,000	19,500							
1		7.81	7.85	7.85	7.80							
2		7.92	7.99	7.95	7.88							
3		7.96	8.00	7.91	7.86							
4		8.15	8.11	8.06	8.09							
5		3.39	3.20	3.20	3.24							
6		3.42	3.25	3.30	3.21							
7		3.65	3.60	3.87	3.42							
8		3.79	4.02	4.09	3.40							
9		3.80	4.23	4.11	3.28							
10		3.85	4.58	4.17	3.80							
11		3.97	4.89	4.18	2.35							
12		4.18	5.15	4.18	2.15							
13		4.48	5.31	4.17	2.07							
14		4.79	5.41	4.20	2.09							
15		5.10	5.51	4.30	2.20							
16		5.40	5.63	4.41	2.42							

MANOMETER DATA

WAKE RAKE

Rake Location: 3.5" Aft, #4,16 centevel
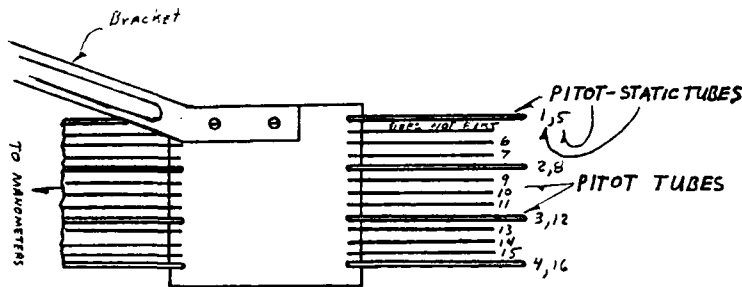
Sheet No. 12

Comments: Run 5.02

[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: 30°

MANOMETER INCLINE: _____

Tube #		5000	11,000	15000	19,500
1	785	7.85	7.96	7.86	7.72
2		8.10	8.09	7.92	7.85
3		8.86	8.21	7.95	8.05
4		10.24	8.50	7.80	8.39
5		4.84	5.49	4.30	2.19
6		4.99	5.53	4.29	2.14
7		5.37	5.68	4.41	2.33
8		5.38	5.65	4.60	2.78
9		5.50	5.60	4.70	3.10
10		6.22	5.78	4.70	3.38
11		6.63	5.77	5.14	3.82
12		6.67	5.80	5.48	4.86
13		7.60	6.84	5.89	5.46
14		7.71	6.64	5.57	6.32
15		7.80	7.15	6.90	6.40
16		8.17	7.50	7.10	6.52

Location

MANOMETER DATA

WAKE RAKE   Sheet No. _12 A_

Rake Location: __3.5" Aft, centered on #4,16 -5.03__ Comments: _T ... 5-03 & 5.04 &_
_____3.5" Aft, 1.1" Off Cntr____ — S.04 _____5.05_____
_____"_____"_____ -- 5.05
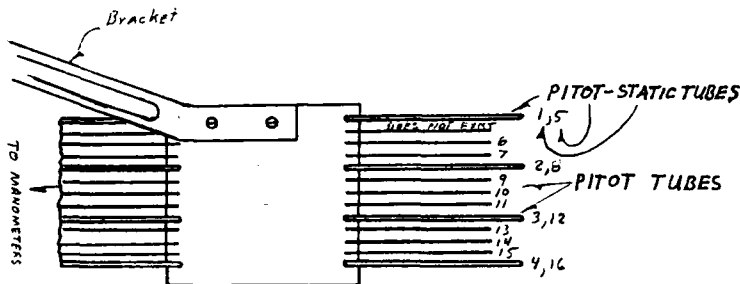
Bracket

TO MANOMETERS

PITOT-STATIC TUBES 1,5
PITOT TUBES 2,8
tubes not exist
6 7 9 10 11 3,12 13 14 15 4,16

[WAKE RANK LAYOUT]   MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: _____   MANOMETER INCLINE: _____

Tube #	RUN 5-03	RUN 5.04	RUN 5.05 RPM		
			11,000	15,000	19,500
1	7.68	7.70	7.78	7.70	7.71
2	7.71	7.75	7.81	7.78	7.86
3	7.73	7.74	7.81	7.75	7.77
4	7.83	7.85	7.95	7.90	8.00
5	3.92	3.72	3.75	3.65	3.50
6	4.09	3.69	4.11	4.02	3.63
7	4.40	3.95	4.36	4.10	3.70
8	4.54	4.02	4.50	4.11	3.04
9	4.68	3.79	4.60	3.94	3.47
10	4.96	3.91	4.78	3.78	3.35
11	5.19	3.64	4.94	3.91	3.21
12	5.50	3.90	5.10	3.88	2.22
13	6.13	3.90	5.37	3.98	2.21
14	6.69	4.09	5.40	4.01	2.41
15	6.89	4.42	5.58	4.25	2.60
16	7.20	4.42	5.69	4.50	2.99

Location

MANOMETER DATA

WAKE RAKE

Sheet No. _13_

Rake Location: _3.5" Aft, Pitch 4,16 Centered_

Comments: _Run 5.06_
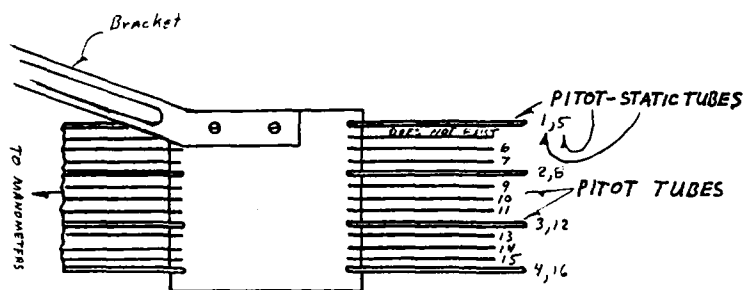
[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: _30°_

MANOMETER INCLINE: _____

Tube #			RPM 11,000	15,000	19,500	Location							
1			7.79	7.73	7.70								
2			7.86	7.79	7.80								
3			7.97	7.81	8.01								
4			8.14	8.00	8.18								
5			5.34	4.01	2.40								
6			5.46	4.07	2.39								
7			5.63	4.25	2.52								
8			5.69	4.58	3.02								
9			5.61	4.65	3.30								
10			5.80	4.90	3.70								
11			5.87	5.11	4.30								
12			5.88	5.59	5.12								
13			6.13	5.95	5.73								
14			6.50	6.41	6.44								
15			7.05	6.88	6.80								
16			7.38	7.32	6.94								

A73

MANOMETER DATA

WAKE RAKE

Sheet No. 14

Rake Location: 3.5" Aft of tail burn

2.2" off cntr to #4,16 — Run 1.18

3.3" " " " — Run 1.19

Comments: $q \approx 13.5$
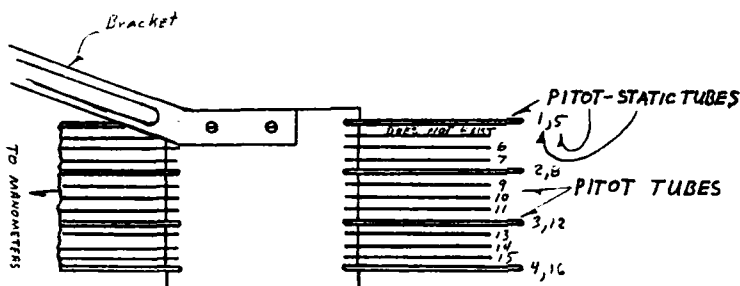
[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: 30°

Tube #		Run 1.18	Run 1.19		
1		7.78	7.74		
2		7.81	7.80		
3		7.80	7.80		
4		8.20	8.01		
5		3.68	3.36		
6		3.62	3.37		
7		3.60	3.46		
8		3.44	3.51		
9		3.38	3.58		
10		3.29	3.62		
11		3.20	3.65		
12		3.17	3.61		
13		3.18	3.60		
14		3.15	3.57		
15		3.15	3.52		
16		3.15	3.40		

MANOMETER INCLINE: _____

Location							

A74

MANOMETER DATA

WAKE RAKE

Sheet No. _____ 15 _____

Rake Location: Pitots aligned with leading
edge of fins
#4 ; 0.110" from boom surface

Comments: _____ q = 13.5 _____
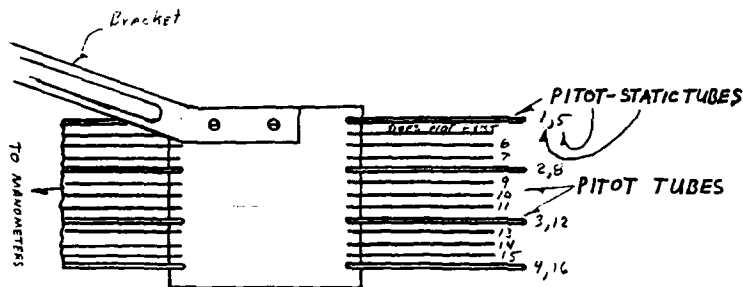
[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: _____

MANOMETER INCLINE: _____

Tube #	y	Run 1.20	Run 1.21		
1		7.10	7.09		
2		7.03	7.01		
3		6.82	6.93		
4		6.68	6.95		
5		3.19	3.16		
6		3.17	3.15		
7		3.20	3.20		
8		3.23	3.26		
9		3.30	3.31		
10		3.39	3.49		
11		3.48	3.80		
12		3.65	4.35		
13		3.31	4.74		
14		4.07	3.29		
15	0.26	4.40	5.81		
16	0.11	4.91	6.41		

Location

A75

MANOMETER DATA

WAKE RAKE
Pitots 3.5" Aft of Tail boom

Rake Location: #4,16 on ℄

Comments: Propulsion Tests 6-1-79
Run 5.07 & 5.08
11,000 Rpm to 12,400
during manometer readings

Wake Rake Pitot #1,5 bent by
prop spinning off. See new
spacing below under "Y"
Kerosene S.G. =0.8

Y= distance normal to vehicle
longitudinal axis

[WAKE RANK LAYOUT]
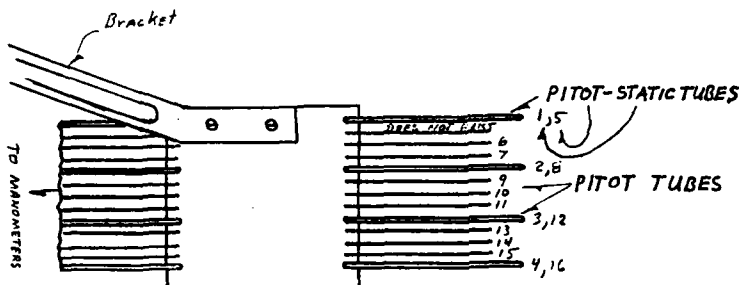
MISCELLANEOUS PRESSURE READING

Note: Manometer zero reference is atmospheric pressure for sheets 10 thru 13

MANOMETER INCLINE: _____30°_____   MANOMETER INCLINE: _____30°_____

Tube #	Y	5.07 NO PROP	RPM 11,000	5.08 15,000	19,500
1		3.82	3.74	3.68	3.72
2		3.74	3.77	3.69	3.73
3		3.74	3.80	3.71	3.75
4		3.82	3.97	3.80	3.82
5	1.325	1.43	2.14	1.63	0.38
6	1.215	1.26	2.15	1.60	0.33
7	1.100	1.30	2.22	1.67	0.39
8	0.990	1.39	2.27	1.72	0.53
9	0.870	1.47	2.26	1.79	0.72
10	0.745	1.59	2.49	1.88	0.88
11	0.622	1.77	2.61	1.98	1.10
12	0.500	2.02	2.67	2.10	1.35
13	0.360	2.32	2.75	2.22	1.44
14	0.255	2.60	2.87	2.33	1.80
15	0.115	2.77	2.80	2.48	2.22
16	0	2.83	3.02	2.68	2.48

Location

A76

MANOMETER DATA

WAKE RAKE

Pitots 3.5" Aft of tail Boom

Rake Location: #4,16 on ℄

Comments: Run S.10 Clipped 5D×5"P

Bracket

PITOT-STATIC TUBES
PITOT TUBES
TO MANOMETERS

[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: ___30___

MANOMETER INCLINE: _____

Tube #	Y	11,000	15,000	19,500	24,400	Location						
1		3.75	3.70	3.78	3.87							
2		3.78	3.71	3.75	3.87							
3		3.82	3.75	3.81	4.04							
4		4.14	3.85	3.90	4.25							
5		2.70	1.66	0.69								
6		2.20	1.65	0.57								
7		2.06	1.69	0.59								
8		2.40	1.77	0.72								
9		2.40	1.85	0.84								
10		2.52	1.96	1.10								
11		2.56	2.03	1.22	0.12							
12		2.60	2.20	1.42	0.54							
13		2.75	2.47	1.46	1.28							
14		2.84	2.57	1.82	1.92							
15		2.99	2.52	2.26	2.32							
16		3.33	2.70	2.53	2.47							

A77

MANOMETER DATA

WAKE RAKE

Rake Location: _As on Sheet 17 H_

Comments: _____
Run 5.12 – 5"D x 4"P Yellow BW
___5.13___ '' ___ '' Clipped
_____
_____
_____
_____
_____

Bracket

TO MANOMETERS

PITOT-STATIC TUBES
1,5

PITOT TUBES
2,8

3,12

4,16

[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: ___30°___   MANOMETER INCLINE: _____

Tube #	← Run 5.12 →			← Run 5.13 →		11,000	15,000					
	11,000	15,000	17,400	17,400	18,500							
1	3.74	3.77	3.78	3.70	3.77	3.74	3.72					
2	3.77	3.77	3.77	3.69	3.75	3.75	3.71					
3	3.81	3.78	3.80	3.75	3.84	3.79	3.76					
4	4.04	3.85	3.83	3.82	3.89	4.01	3.83					
5	1.80	0.985	0.07	0.28	0.04	1.63	0.83					
6	1.83	0.79	0.04	0.28	0.06	1.70	0.85					
7	1.95	0.79	0.13	0.42	0.17	1.83	1.00					
8	2.05	1.09	0.36	0.55	0.32	1.95	1.16					
9	2.12	1.25	0.63	0.73	0.50	2.04	1.28					
10	2.24	1.48	0.88	0.88	0.65	2.18	1.43					
11	2.36	1.72	1.19	1.18	0.96	2.33	1.69					
12	2.51	1.83	1.45	1.46	1.23	2.46	1.88					
13	2.65	2.04	1.53	1.55	1.42	2.58	1.98					
14	2.73	2.22	1.86	1.85	1.82	2.68	2.15					
15	2.87	2.42	2.25	2.20	2.20	2.82	2.36					
16	3.22	2.63	2.50	2.24	2.44	3.17	2.54					

MANOMETER DATA

WAKE RAKE

Rake Location: Ason Sheet 17

Comments: Run 5,14
2 — 5"Dx4"P Clipped
6-Bladed Prop
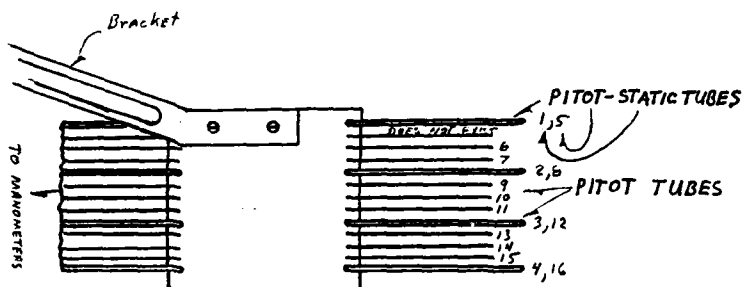
Bracket

PITOT-STATIC TUBES
1,5

PITOT TUBES
2,6

3,12

4,16

TO MANOMETERS

[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: ___30___

MANOMETER INCLINE: _____

Run 5.14

Tube #	11,000	15,000	17,300		
1	3.72	3.75	3.89		
2	3.74	3.74	3.87		
3	3.83	3.76	3.92		
4	4.03	3.84	3.94		
5	1.94	0.78	0.0		
6	1.98	0.74	0.0		
7	1.14	0.92	0.12		
8	2.27	1.18	0.43		
9	2.37	1.35	0.73		
10	2.53	1.55	0.94		
11	2.69	1.80	1.27		
12	2.87	2.07	1.57		
13	3.08	2.23	1.77		
14	3.25	2.48	2.14		
15	3.48	2.73	2.44		
16	3.78	2.98	2.67		

Location

A79

MANOMETER DATA

WAKE RAKE

Rake Location: As on Sheet 17

Comments: Run 5,16

Manometer reference shifted down 2.0"
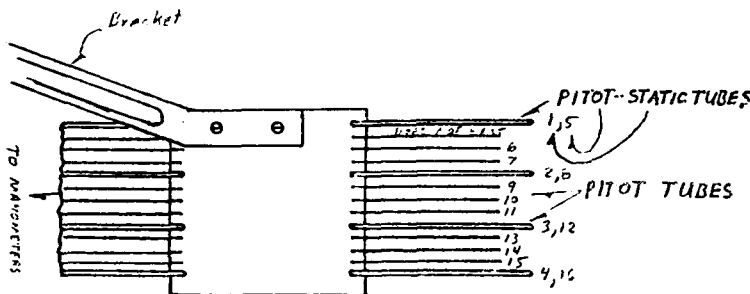From sheet 14 on

[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: 30°

MANOMETER INCLINE: _____

| Tube #	11,50	15,000	19,500	24,400	
1	5.72	5.72	5.75	6.10	
2	5.75	5.72	5.70	5.79	
3	5.78	5.77	5.84	6.12	
4	5.84	6.08	6.25	6.89	
5	3.38	3.31	3.28	3.56	
6	3.48	3.24	3.02	2.18	
7	3.57	3.12	2.43	1.35	
8	3.68	3.14	2.34	1.13	
9	3.77	3.24	2.45	1.35	
10	3.91	3.39	2.76	1.88	
11	4.11	3.58	3.00	2.20	
12	4.29	3.87	3.27	2.53	
13	4.35	4.10	3.62	3.21	
14	4.47	4.32	3.97	3.75	
15	4.62	4.65	4.44	4.55	
16	4.72	4.99	4.85	5.25	

Location

MANOMETER DATA

WAKE RAKE

Rake Location: Same as Sheet #17

Comments: Run 5.18
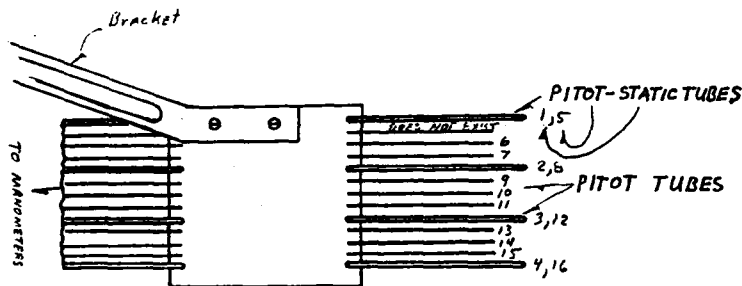
[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: 30°

MANOMETER INCLINE: _____

Tube #	11,000	15,000	19,500		
1	5.70	5.71	5.78		
2	5.69	5.71	5.71		
3	5.71	5.72	5.80		
4	5.79	5.98	6.56		
5	3.38	3.31	3.31		
6	3.49	3.27	2.81		
7	3.62	3.30	2.55		
8	3.71	3.25	2.55		
9	3.82	3.36	2.70		
10	3.96	3.58	3.05		
11	4.14	3.72	3.24		
12	4.39	3.91	3.44		
13	4.59	4.16	3.75		
14	4.84	4.46	4.19		
15	5.09	4.88	5.20		
16	5.30	5.50	6.35		

Location

A81

MANOMETER DATA

WAKE RAKE
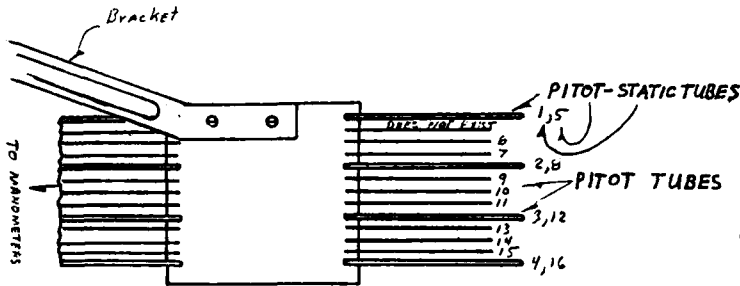
Rake Location: Pitots #4,16 on ₵ of vehicle
3.5" From tail boom to
total pressure tubes

Comments: Run 5.19 & 5.20 at α=0

Pitot Static #1,5 straightened
since sheet 19 measurement
16 to 5 = 1.32"   ← Double Check This
Other spacings same as sheet 10

~~Ambient reference 2.00" below~~
Atmospheric reference 2.00"
above scale reading zero
i.e. Atmospheric P = 2.00"

[WAKE RANK LAYOUT]

Bracket

PITOT-STATIC TUBES
1,5
6
7
2,8
9
10
11
3,12
13
14
15
4,16

PITOT TUBES

TO MANOMETERS

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: __30°__

← Run 5.19 →	Run 5.20		
Tube #	11,000	15,000	0 RPM		
1	5.55	5.50	5.55		
2	5.59	5.53	5.60		
3	5.64	5.55	5.67		
4	5.64	5.69	5.75		
5	3.28	3.25	3.23		
6	3.42	3.18	3.28		
7	3.52	3.04	3.34		
8	3.60	3.08	3.42		
9	3.69	3.15	3.49		
10	3.81	3.34	3.60		
11	3.94	3.51	3.71		
12	4.10	3.74	3.83		
13	4.25	4.04	3.98		
14	4.57	4.40	4.14		
15	4.99	4.84	4.56		
16	3.46	5.69	4.99		

MANOMETER INCLINE: _____

Location

A82

MANOMETER DATA

WAKE RAKE

Rake Location: _____

Sheet No. _23_

Comments: _____

<u>24,400 RPM Ref is 1.27" Atmospheric</u>

Bracket

PITOT-STATIC TUBES

PITOT TUBES

TO MANOMETERS

[WAKE RANK LAYOUT]

<u>MISCELLANEOUS PRESSURE READING</u>

MANOMETER INCLINE: _30°_

MANOMETER INCLINE: _____

STROKE→

Tube #	11,000	15,380	Reset Ref 20,400	Reset Ref 22,580	
1	5.09	5.00	6.04	7.39	
2	5.13	5.09	5.98	7.18	
3	5.20	5.14	6.29	7.70	
4	5.30	5.40	6.40	7.75	
5	1.17	1.45	2.09	3.40	
6	1.40	1.10	1.65	2.46	
7	1.58	0.80	0.24	0.55	
8	1.71	0.81	0.08	0.25	
9	1.90	0.99	0.32	0.56	
10	2.10	1.28	0.81	1.11	
11	2.30	1.57	1.21	1.60	
12	2.54	1.98	1.79	2.25	
13	2.80	2.56	2.94	3.78	
14	3.28	3.09	3.68	4.70	
15	3.89	3.60	3.90	4.88	
16	4.10	4.22	4.56	5.70	

Location

MANOMETER DATA

WAKE RAKE

Sheet No. 24

Rake Location: A 23

Comments: thrust saturates out at ≈24,000
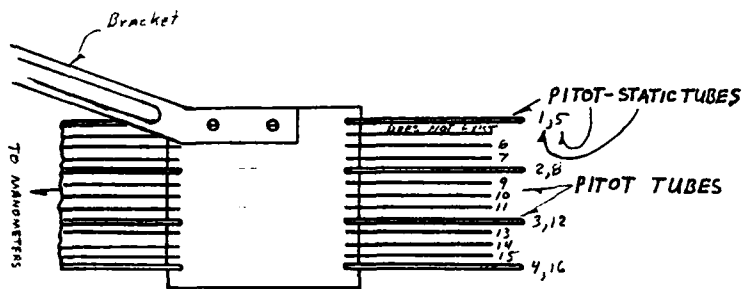
[WAKE RANK LAYOUT]

Bracket

TO MANOMETERS

PITOT-STATIC TUBES
1,5

2,8 → PITOT TUBES

3,12

4,16

6
7
9
10
11
13
14
15

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: _____

MANOMETER INCLINE: _____

STROBE → 11,300   15,320   >23,400
                              24,000

Tube #					
1	4.31	4.30	4.20		
2	4.91	4.80	4.39		
3	4.80	4.62	4.36		
4	5.49	5.00	4.60		
5	0.28	0.29	0.29		
6	0.33	0.35	0.31		
7	0.66	0.54	0.49		
8	2.08	1.63	1.20		
9	2.59	2.42	1.48		
10	2.70	2.50	1.55		
11	2.84	2.66	1.52		
12	3.09	2.82	1.55		
13	3.37	3.01	1.84		
14	3.95	3.38	2.38		
15	4.91	3.88	2.99		
16	5.42	4.41	3.70		

Location

MANOMETER DATA

WAKE RAKE

Rake Location: As on 21/15

Comments: Run 5.23
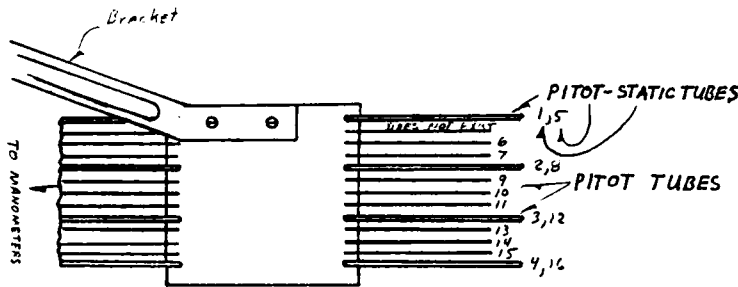
Bracket

TO MANOMETERS

PITOT-STATIC TUBES

PITOT TUBES

1,5
6
7
2,8
9
10
11
3,12
13
14
15
4,16

[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: 30°

MANOMETER INCLINE: _____

Reset Zero

12,400 5,400

Tube #	11,000	15,000	20,000		
1	4.30	4.78	6.39		
2	4.39	4.87	6.50		
3	4.54	4.96	6.57		
4	4.62	5.10	6.70		
5	0.95	4.19	0.22		
6	1.02	4.24	0.30		
7	1.17	4.42	0.51		
8	1.38	4.70	0.90		
9	1.65	0.99	1.38		
10	2.00	1.40	1.90		
11	2.30	1.85	2.60		
12	2.56	2.38	3.34		
13	2.88	2.88	3.91		
14	3.25	3.38	4.95		
15	3.72	3.80	5.18		
16	4.20	4.20	8.51		

Location

A85

MANOMETER DATA

WAKE RAKE

Rake Location: As on t6 23

Comments: Run 5,24

Bracket

PITOT-STATIC TUBES
1,5

TO MANOMETERS

Ref. itot rake
6
7
2,8 — PITOT TUBES
9
10
11
3,12
13
14
15
4,16

[WAKE RANK LAYOUT]
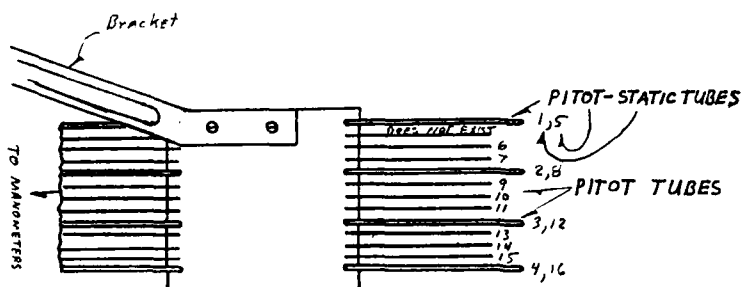
MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: 30°

MANOMETER INCLINE: _____

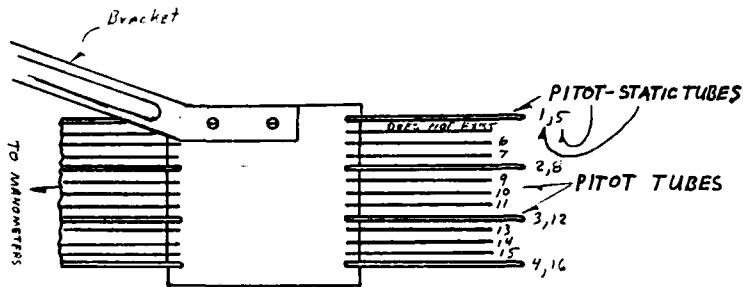| Tube #	11,000	15,000	18,400		
1	4.91	5.35	6.80		
2	5.00	5.50	7.00		
3	5.19	5.55	7.01		
4	5.49	5.69	7.18	7.18	
5	1.50	0.54	0.30		
6	1.62	0.61	0.46		
7	1.83	0.84	0.74		
8	2.01	1.21	1.30		
9	2.28	1.60	1.98		
10	2.61	2.04	2.59		
11	2.98	2.50	3.31		
12	3.22	2.99	4.00		
13	3.57	3.45	4.56		
14	3.95	3.96	5.22		
15	4.41	4.42	5.76		
16	4.90	4.81	6.09		

Location

A86

MANOMETER DATA

WAKE RAKE

Rake Location: As on 16 [23]

Comments: Run 5.25
Octura 1270

Manometer reference shifted
arbitrarily on each RPM

Bracket

TO MANOMETERS

Def: Hal Press

PITOT-STATIC TUBES   1,5
6
7   2,8
9   PITOT TUBES
10
11   3,12
13
14
15   4,16

[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: 30

MANOMETER INCLINE: _____

Set by strobe

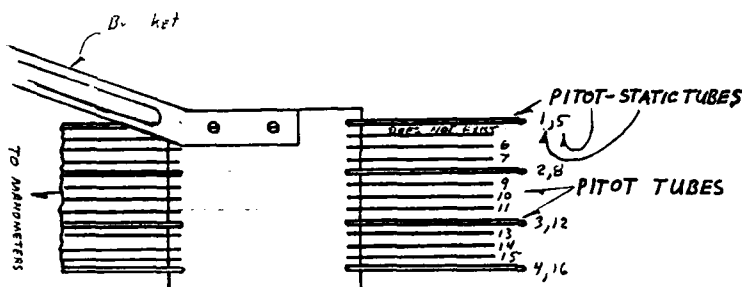| Tube #	11,000	15,000	18,400	22,000	25,000
1	4.74	4.58	4.40	4.70	5.72
2	4.72	4.60	4.50	4.77	5.78
3	4.83	4.67	4.50	4.83	5.97
4	5.25	4.78	5.19	6.47	8.17
5	0.76	0.57	0.59	0.88	1.90
6	1.63	1.10	0.61	0.75	1.65
7	2.22	1.39	0.65	0.30	0.50
8	2.22	1.49	0.70	0.20	0.24
9	2.36	1.61	0.80	0.23	0.21
10	2.42	1.77	0.97	0.40	0.42
11	2.69	1.93	1.18	0.68	0.80
12	2.90	2.10	1.45	1.05	1.35
13	3.11	2.40	1.90	1.89	2.50
14	3.47	2.78	2.40	2.40	2.96
15	3.80	3.00	3.29	3.91	5.00
16	4.20	3.59	5.00	6.60	8.55

Location

MANOMETER DATA

WAKE RAKE

Rake Location: As on ₁₆²³

Sheet No. ²⁸ 27

Comments: Run 5.26 & 5.27

Grey 2 Bld Airplane 2"P

Manometer Ref. reset

[WAKE RANK LAYOUT]

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: 30°

-- by Strobe   Run 5.26 | Run 5.27
                            | NO PROP |

Tube #	11,000	15,000	18,400	24,150	0
1	4.90	4.84	4.72	5.19	5.25
2	5.08	4.98	4.83	5.28	5.34
3	5.35	5.17	4.91	5.35	5.41
4	5.68	5.34	5.06	5.55	5.53
5	2.00	1.84	5.26	0.30	1.29
6	2.30	1.90	1.30	0.32	1.31
7	2.76	2.06	1.45	0.51	1.43
8	2.91	2.27	1.60	0.80	1.57
9	3.07	2.58	1.80	1.10	1.72
10	3.34	2.83	2.03	1.39	1.90
11	3.41	3.00	2.31	1.70	2.10
12	3.30	3.10	2.59	2.18	2.38
13	3.33	3.19	2.80	2.72	2.60
14	3.11	3.17	3.01	3.44	2.91
15	3.29	3.38	3.41	4.15	3.54
16	4.00	3.89	3.84	4.57	4.11

MANOMETER INCLINE: 30°

Run 5.27   NOT RUN

Location	11,000	15,000	18,400	24,150	

A88

MANOMETER DATA

WAKE RAKE

Rake Location: _____

[WAKE RANK LAYOUT]

Comments: Tunnel Survey
with sandwich of
3 honeycomb panels at
exit of entrance cone
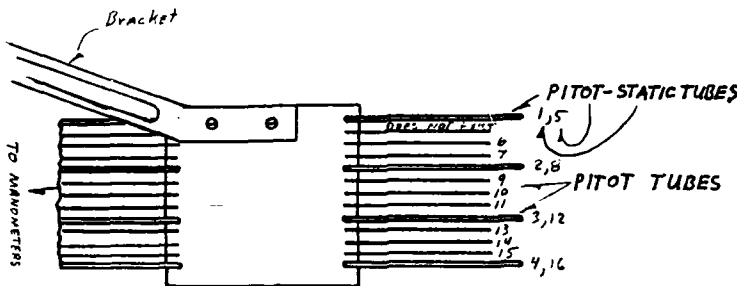
Zero is 15.5" from tunnel floor

$q = 13.5$

MISCELLANEOUS PRESSURE READING

MANOMETER INCLINE: _____

MANOMETER INCLINE: ___30°___

← Make 34.75"

Tube #						
1 2						
3 4						
5 6						
7 8						
9 10						
11 12						
13 14						
15 16						

Location	P_S	P_T			
35,0,0	8.00	3.43			
35,0,2.5"	8.05	3.22			
35,0,5"	8.08	3.29			
35,0,7.5"	8.10	3.59			
35,0,10"	8.10	3.82			
35,0,-2.5"	8.09	3.55			
35,0,-5.0"	8.10	3.80			
35,0,-7.5"	8.09	4.07			
35,0,-10"	8.06	3.05			
35,0,-12.5"	8.03	3.82			

MANOMETER DATA

WAKE RAKE

Rake Location: _____

Comments: Same As ~~16A~~ 29
Except Longitudinal Survey
C
_____
_____
_____
_____
_____
_____
_____

Bracket

TO MANOMETERS

Does Not Exist

PITOT-STATIC TUBES
1,5
6
7
2,8
PITOT TUBES
9
10
11
3,12
13
14
15
4,16

[WAKE RANK LAYOUT]
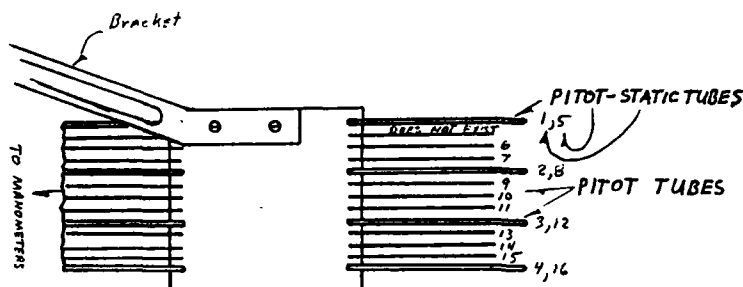
MISCELLANEOUS PRESSURE READING

YAW HEAD

MANOMETER INCLINE: _____

MANOMETER INCLINE: _____30°_____

Tube #					
1 2					
3 4					
5 6					
7 8					
9 10					
11 12					
13 14					
15 16					

Location	P_s	P_T			
28", 0,0	7.94	3.47			
23.5", 0,0	8.00	3.43			
17.0", 0,0	8.20	3.45			
11.5", 0,0	8.10	3.40			

A90

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1 REPORT NUMBER	2 GOVT ACCESSION NO. $AD-A100759$	3 RECIPIENT'S CATALOG NUMBER
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Distribution unlimited

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18 SUPPLEMENTARY NOTES

19 KEY WORDS (Continue on reverse side if necessary and identify by block number)

hydrodynamics	wind tunnel tests	static stability
laminar flow tests	hull & fin lift drag characteristics	tests
powered model tests	flow separation	boundary layer
propeller tests	flow visualization	measurements

20 ABSTRACT (Continue on reverse side if necessary and identify by block number)

A series of wind tunnel tests was conducted from 15 April 1979 to 14 June 1979 at the University of Washington's 3-ft Venturi tunnel to gather data relevant to the solution of a propulsion problem and to support a fin redesign effort for the Advanced Expendable Mobile Target (AEMT). This report outlines the test setups, describes the types of tests performed, and presents selected results. In addition, all of the raw data gathered during the tests are contained in an appendix.

DD FORM 1473 EDITION OF 1 NOV 65 IS OBSOLETE
1 JAN 73
S/N 0102 LF 014 6601

END

DATE
FILMED

7-81

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